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Enwright, J., Haught, D., & Akman, A. (1991). Conceptual design for a task and training trade-off identification model. WP GORDON 91-03.

Finley, D.L., & Shipman, M.G. (1989). 39L and 39Y merger action: Inputs to development of-training strategy. WP GORDON 89-202.

Loungeway, A. (1990). Military Occupational Specialty (MOS) 29M and MOS 29V merger action: A case study. WP GORDON 90-202.

Loungeway, A. (1990). Military Occupational Specialty (MOS) 29M and MOS 29V merger action plan. WP GORDON 90-203.

Shipman, M.G., Bing, V.B., & Finley, D.L. (1990). Test and evaluation of the Military Occupational Specialty (MOS) equipment evaluation form. WP GORDON 90-201.

Shipman, M.G., York, W.J., Legree, P.J., & Bing, V.B. (1991). Analysis of the attrition of the Military Occupational Specialty (MOS) Special Electronic Devices Repairer (39E) students. WP GORDON 91-02.

Steinbach, C., Akman, A., Finley, D.L., & York, W.J. (1991). Developing an equipment domain model for use in MOS restructuring. WP GORDON 91-04.

Steinbach, C., Akman, A., & Haught, D. (1991). Military Occupational Specialty (MOS) restructuring research and development blueprint., WP GORDON 91-01.

PROTOTYPE MILITARY OCCUPATIONAL SPECIALTY CONSTRAINTS MODEL (MCM)

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PROTOTYPE MILITARY OCCUPATIONAL SPECIALTY CONSTRAINTS MODEL (MCM)

EXECUTIVE SUMMARY

Research Requirements:

Research into the Military Occupational Specialty (MOS) restructuring process has identified a critical need for more systematic methods and analytical tools to facilitate the design and implementation of new MOSs. One such methodological requirement is a standard method for identifying and estimating the values of manpower, personnel, and training (MPT) constraints which cannot be exceeded by restructured MOSs.

The purpose of this report is to present design concepts for an MOS Constraints Model (MCM). This constraint-defining tool has been designed for use in support of MOS restructuring and largely uses existing Army data sources.

Procedure:

Development of MCM was initiated by an examination of existing Army tools and data bases which might be used to meet its methodological or data requirements. Based on requirements of the restructuring process and assessments of the utility of existing Army tools and data bases, design concepts were developed for MCM. Attention focused on constraints identification, estimation of constraint values, and assessment of impacts on MOS restructuring.

MCM concepts were tested in a sample constraint setting application based on an MOS merger action in which two engineer MOSs are being combined together into one. Using MCM, constraints were identified, values estimated, and impacts assessed.

Findings:

As result of this research, an MCM was formulated which can be used by combat developers, training developers, and personnel proponents responsible for MOS restructuring analyses. Values for most constraints can be estimated using data from the Headquarters Department of Army FOOTPRINT decision support system.

Utilization of Findings:

The MCM design concepts developed and illustrated in this research can be formalized and proceduralized to create a constraint setting tool (computer-based or manual) for use in MOS restructuring. This can meet a critical requirement in an emerging MOS restructuring decision support technology.

PROTOTYPE MILITARY OCCUPATIONAL SPECIALTY CONSTRAINTS MODEL (MCM)

CONTENTS

Page

List of Figures

CONTENTS (CONTINUED)

Page

List of Tables

PROTOTYPE MILITARY OCCUPATIONAL SPECIALTY CONSTRAINTS MODEL (MCM)

Introduction

Because of a rapidly decreasing force structure, the Army's branch proponents (usually the service schools) face difficult challenges in estimating future manpower, personnel, and training (MPT) requirements and constraints. As the Army reduces in size, Career Management Fields (CMFs) and Military Occupational Specialties (MOSs) will be impacted in terms of resources. Among the personnel and training areas that may be impacted are grade structures; Armed Services Vocational Aptitude Battery (ASVAB) scores; number of MOS positions authorized (manpower ceilings); trainees, transients, holdees, and students (TTHS) accounts; number of training hours; number of training seats; and instructor contact hours.

The work described in this research paper is anchored in previous investigations into the MOS restructuring process conducted over the past two years (Akman and Haught, 1990; Haught, Akman and Finley, 1990; and Steinbach, Akman, and Haught, 1990). The focus of the research reported here is to identify requirements for knowing and defining personnel and training constraints in support of MOS restructuring at Army service schools. To accomplish this, a baseline was established with respect to the state of current capability and the requirements for new techniques.

This document describes an MOS Constraints Model (MCM) for identifying personnel and training resource constraints. MCM is a simple job aid providing standard procedures for determining MOS constraints using, to the maximum extent practical, existing data to assign constraint values. The model focus was the Active Army. Subsequent research will identify model refinements necessary to address Reserve and National Guard components.

Background

One of the many dilemmas facing the branch proponent during the restructure or merger of an MOS or CMF is trying to estimate the future manpower, personnel, and training requirements and constraints. In the context of this effort, personnel and training requirements are characterized as the manpower pool, personnel characteristics, training, and facilities needed to ensure the capability to properly manage and educate personnel in Army MOSs. Constraints are delineated as any regulatory, policy, or doctrinal guidance that influence the resourcing of current or projected personnel and training requirements. Executing MOS restructuring actions that are in compliance with personnel and training constraints is a primary concern of every branch combat

developer (CD), training developer (TD), and personnel proponent as actions that do not meet these criteria have less chance of approval by Headquarters Department of the Army (HQDA), particularly if the violation of constraints is recognized and there is no compensating adjustment.

Overview of the Report

This report is organized into five sections. The first provides an overview of the MOS restructuring process and discusses how and at what level constraints interact and impact on restructuring. The second section provides an overview of the MCM concept, its principal functional capabilities, its users, and applications. The third section describes MCM's three processes: constraints identification, constraints estimation, and constraints impact assessment. The fourth section illustrates the use of MCM in defining constraints for a hypothetical MOS merger based on MOS 12B and MOS 12C being combined into an MOS 12A. The final section discusses requirements and opportunities related to further MCM development.

An appendix contains procedures for estimating values for five different constraints discussed in the MOS 12B and MOS 12C example. The constraints include authorizations, grade structure, ASVAB score, accessions, and student training person years.

MPT Constraints and MOS Restructuring

MPT constraints in the context of MOS restructuring represent limits in terms of various MPT characteristics which cannot be exceeded by the modified MOS without making a conscious decision to do so. There are constraints as result of policy, regulation, common practice, and resource limitations, among other sources; these constraints may be promulgated officially or unofficially from HQDA, from commands such as Training and Doctrine Command (TRADOC), from the training centers, and from the personnel proponents, among other agencies. Meanwhile, the MOS restructure action under consideration generates requirements associated with a notional MOS. In MOS restructuring, trade-offs among MOS-based MPT characteristics must be considered until the requirements of the notional MOS no longer exceed constraints; otherwise, approval of the proposed restructured MOS is not likely.

The purpose of this section is to provide an overview of the MOS restructuring process and to discuss how and at what level constraints interact and impact on the process. This discussion provides the framework for the development and application of MCM. First, the features of MOS restructuring as a constrained process are discussed. Second, requirements for MCM and its place in the MOS restructuring process are described. Finally, the MPT variables that are most commonly constrained in this context are identified and defined.

The Constrained MOS Restructuring Process

MOS restructuring involves revising the task composition of an MOS either by eliminating tasks, adding tasks, merging tasks with another MOS, or by aggregating mission tasks into an entirely new MOS. MOS restructuring is an iterative process by which strategic and implementation requirements are projected, compared with constraints, traded off, refined, and reconsidered. Once a notional MOS is proposed, analysis initially centers on strategic issues. This begins early in the new doctrine or equipment development cycle and continues through documentation and implementation of new doctrine into the Army's force structure or the final documentation of the equipment item in Army tables of organization and equipment (TOE).

Later, the focus shifts predominantly to implementation issues. This aspect of restructuring focuses on implementing the requirements of the notional MOS in the context of the Army personnel management system. (See Akman and Haught, (1990); Haught, Akman, and Finley (1990); and Steinbach, Akman, and Haught, (1990) for more detailed information on MOS restructuring.)

During the process of restructuring or merging MOSs, the CD, TD, and personnel proponent must constantly keep in mind that the MPT requirements identified during the restructuring effort must satisfy various MPT constraints. One most often recognized and addressed, for example, is "length of schoolhouse training" which according to TRADOC policy generally cannot be greater for the new MOS than it was previously under the old MOS structure if the length increases the student training person year requirement. In order to successfully restructure an MOS, MPT constraints must be identified and evaluated against the MOS requirements as they evolve throughout the process. MOS requirements that cause the MPT constraints to be exceeded must be reexamined. Throughout the MOS restructuring process, this reexamination will often occur explicitly or implicitly as a trade-off analysis bounded by the constraints.

The CD, TD, and personnel proponent at the branch proponent agencies are charged with the responsibility of identifying and satisfying MPT constraints during the MOS restructuring process. Effective MOS restructuring requires the branch proponent to meet MPT constraints at three different levels: the CMF, the MOS, and the task levels of detail.

CMF level constraints. CMF level constraints must be considered in MOS restructuring in order for the revised MOS to be integrated satisfactorily into its CMF. This level of constraints assessment allows the proponent to evaluate MPT requirements against CMF level constraints and determine if an MOS restructuring decision either constrains other CMF initiatives or if CMF requirements pose unresolvable constraints on the MOS. Examples of MPT domains that might be constrained at the CMF level are:

1. The availability of manpower authorizations needed to support the overall missions and functions of the CMF.

2. The availability of training resources required to support advanced individual training (AIT), Basic Noncommissioned Officers Education System and Advanced Noncommissioned Officers Education System for all MOSs in the CMF that require training.

3. The availability of personnel resources needed to access, develop, field, and sustain the required mix of soldiers needed in all MOSs to support the missions and functions of the CMF.

MOS level constraints. During restructuring, the new or revised MOS must compete with all other MOSs in the CMF for available MPT resources based on the overall CMF mission and the priority of

the MOS within that mission. As a result of this competition, CMF level MPT constraints may be passed down to the MOS level and may be allocated to the MOS undergoing restructuring. In addition, certain MPT constraints arise at the MOS level independent of but consistent with the CMF level constraints.

Examples of the former, that is CMF level derived MOS constraints, include authorizations and the allocation of AIT, BNCOES, and ANCOES training resources, among others. Grade structure requirements are an example of an MOS level constraint independent of CMF characteristics. When taken together, these variables become the MPT constraints which must be satisfied in order for an MOS restructuring to be approved.

MOS level constraints are most commonly dealt with by the TD, CD, and personnel proponent and require the most interaction between these agencies during the MOS restructuring process. Therefore, MOS level constraints have been selected as the focus for developing MCM and will be addressed more specifically in the balance of this paper.

Task level constraints. While MOS level constraints are the focus of attention, the opportunity to change MPT characteristics and meet MOS level constraints is dependent on manipulation, modification, substitution, and aggregation of individual tasks. Combinations of tasks create different MOS level MPT characteristics profiles. When MOS level constraints are exceeded by a restructured MOS, changes of the task structure are required. These changes must be consistent with constraints operating at the task level at the same time as MOS requirements are being met.

For example, constrained MOS level training may limit the number of tasks that can be effectively taught during formal MOS training. If the number of tasks that must be taught exceeds this constraint, some tasks may be eliminated and others expanded. Increasing the training load on individual tasks may exceed task level training constraints.

Requirements for an MCM in the MOS Restructuring Process

Constraints identification should begin early in the restructuring process at the point a restructuring decision is made and a notional MOS is being identified. Therefore, MCM has a role to play from early in the restructuring analysis through the examination of implementation issues.

Figure 1 highlights the role of MCM as part of the restructuring process. The notional MOS, which represents the initial concept of the restructured MOS, becomes the focus of analysis and the basis, ultimately, of recommendations. The analysis process uses current MOS information, current force

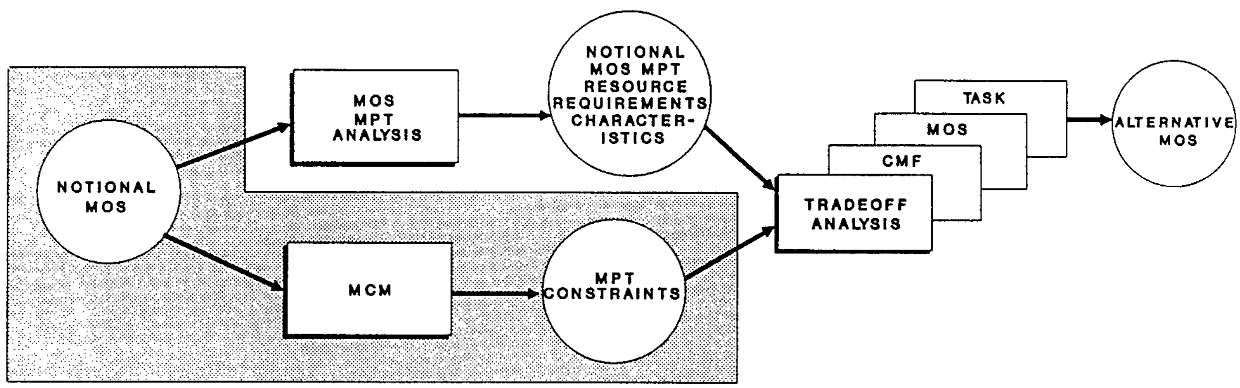

Figure 1. The role of MCM in the MOS restructuring process.

structure requirements, and the requirements demanded by change (new equipment, doctrine, organizations, etc.) to develop the notional MOS. There are several analytical tools within the MOS restructuring technology which can be used to formulate the notional MOS; these include the Equipment Domain Methodology, task aggregation analysis, and the Task Commonality Analysis Method.

Before the notional MOS is confirmed as a recommended course of action, an MPT analysis and a trade-off analysis must be performed; together, these comprise the high-driver analysis which is designed to identify the MPT characteristics of the notional MOS and to determine whether the new MOS has satisfactory MPT characteristics.

MOS manpower analysis. MOS manpower analysis is performed to estimate the total number of authorizations needed to support the notional MOS. This analysis is based upon judgments of the time required and skill levels needed to perform all tasks required of the notional MOS.

MOS personnel analysis. MOS personnel analysis is performed to determine what personnel resources are needed to support the notional MOS. This step of high-driver analysis also assesses the implications of manpower and training on personnel resource requirements.

MOS training analysis. MOS training analysis supports the determination of training requirements. This step of analysis also provides the process for developing an initial training plan based on the tasks selected as critical to the notional MOSs' mission.

Trade-off analysis. Outputs from MOS manpower, personnel, and training analysis provide a composite of the notional MOS's requirements characteristics. Once constraints, on the one hand, and notional MOS requirements and characteristics, on the other hand, have been established, then trade-offs need to be attempted to bring the two into balance. Examples of trade-offs include: the formation of additional skill identifiers (ASIs); identification of bill payers (within or outside of the branch); justification with regard to value gained being worth the cost; organizational changes to reduce manpower requirements (hence lowering the overall MPT cost); and on-the-job training and distributed training. In terms of costs, aptitude and training may of course be traded off against each other. In the figure, trade-off analysis is represented as having three components: CMF, MOS, and task levels of analysis. This is to indicate that trade-off analysis is a multifaceted process that may require trade-offs to occur on at least three levels.

An important controlling factor in the trade-off analysis, particularly in the early stages of MOS restructuring, are MPT constraints which must be satisfied. The MOS technology must provide a procedure by which MPT constraints, whether derived from policy, doctrine, or practice, can be identified and incorporated into the analytical process. That is MCM's function.

MCM generates MPT constraints to be used during trade-off analysis. MCM is depicted as a separate element apart from the analytical components of the high-driver analysis process because constraints estimation is cyclic and must be repeated throughout the MOS restructuring process. As resource requirements for the MOS under consideration become more defined, constraints need to be reevaluated. Therefore, MCM must have utility throughout the MOS restructuring analysis.

MOS Level Constraints

The key to identification of MOS level constraints is first to identify MOS MPT characteristics that could potentially be constrained. Theoretically, there could be many different MOS characteristics that are constrained in one way or another. However the scope of this effort concentrates on the domains of manpower, personnel, and training with consideration of their applicability to MOS restructuring.

Table 1 provides a list of MOS level variables that are potentially constrained. These characteristics are arranged under the MPT domain from which resources are allocated. The following is a definition of each MOS characteristic and a description of how they are potentially constrained.

MOS authorizations. "MOS authorizations" are the number of spaces allocated for fill by MOS incumbents. These spaces reflect the total MOS manpower requirements that are approved and funded by Congress. Authorizations also serve as the authority for Army units to requisition and assign personnel.

Authorizations are generally constrained by budget. Congress sets a limit on how much of the Army's total manpower request it will resource through appropriations. Once Congress has approved the Army's force structure, HQDA allocates these force structure authorizations to all Major Army Commands (MACOM) by MOS based on the priority of the MACOMs' mission. The aggregate of MOS resources allocated to all MACOMs becomes the number of the MOS's authorizations.

MOS trainees, transients, holdees, and students (TTHS) account. The "MOS TTHS account" represents the number of personnel in the MOS that are not available to staff Army units at any given time. TTHS is a representation of operating overhead or costs in

Table 1

MOS Level MPT Constraint Variables

Manpower
Authorizations
Personnel
TTHS Account
Grade Structure
Physical Demands
ASVAB Scores
Accessions
Retention
Combat Probability
Security
Training
Training Person Years
Developer
Instructor
Student
Training Resources

personnel for maintaining and sustaining the MOS. This account includes new soldiers in basic training (BT) or AIT along with MOS incumbents that are between assignments or participating in advanced educational course work.

TTHS is constrained by Congressional and DOD policies that are subject to change from one year to the next. However, the constraint on TTHS is normally 12 percent, plus or minus two percent, of the MOS authorization.

MOS grade structure. "MOS grade structure" is a summary of MOS authorizations by paygrade. This summary reflects the progression pattern of the MOS (E3-E9, E3-E8, etc.) and indicates levels of responsibility.

MOS grade structure is constrained by Congressional budgets and Department of Defense (DOD) guidance. Army policy supports this guidance by disallowing any increases in grade structure without a corresponding bill payer on a one-for-one basis (Army Regulation (AR) 611-1). For example, if a personnel proponent increases the E8 grade membership in an MOS's grade structure by five soldiers, the proponent must also identify a reduction of five E8 authorizations from another MOS within the proponent's CMF.

MOS physical demands. The "MOS physical demands" requirement is defined as the single most physically demanding task the MOS performs. MOS physical demands are classified as either light, medium, moderately heavy, heavy, or very heavy. This MOS characteristic is a constraint in that the most physically demanding task is the upper bound that limits the personnel holding the MOS to those with the requisite strength capabilities.

MOS Armed Services Vocational Aptitude Battery (ASVAB) scores. "ASVAB scores" provide an indication of a soldier's mental capability to successfully perform in an MOS. ASVAB consists of two parts: the Armed Forces Qualification Test (AFQT) and a series of subtests that are used to determine basic Aptitude Areas (AA) of applicants. AFQT categorizes applicants into five test score categories for screening. The scores, which range from zero to 100 with an average of 50, are used to predict trainability and future job performance. About 50 percent of the general recruit population score in the three highest test categories, Categories I to IIIA. The Army has projected that 75 percent of accessions need to be in these categories due to the increasing complexity of Army systems.

Aptitude Area scores are used to support the classification of soldiers into MOSs. Each MOS has a minimum aptitude score. ASVAB recognizes ten aptitude areas such as Combat (CO) and Surveillance and Communications (SC), among others. High scores

in an aptitude area represent a greater level of aptitude than do lower scores. Individual MOS mental requirements are described by ASVAB. The ASVAB score sets the lower limit for intelligence requirements of the MOS, in general, because the soldier with an ASVAB score at the lower limit required by the MOS must be able to successfully learn and perform all mission functions including those requiring the greatest intelligence.

Increases in ASVAB score requirements are constrained by Army policy. The constraints are similar to those used for grade structure in that any increase in ASVAB score requirements in one MOS must be paid for with a like reduction in another MOS within the CMF. However, increases in score requirements that are requested based upon new equipment, technology, or mission changes may be approved by HQDA with sufficient justification.

MOS accessions. "MOS accessions" are the number and quality of soldiers required to be inducted into the Army to support MOS mission and authorization requirements. Several factors play a role in constraining accessions. Among these are budget, ASVAB score requirements, training requirements (availability of training seats), MOS recruitment priority, total number of MOS authorizations, MOS retention rates, and MOS promotion rates.

MOS retention. "MOS retention" is the number and quality of soldiers that must be retained in service to support MOS mission and authorization requirements. Some of the factors that play a constraining role in MOS retention are budget, skill qualification test scores, accession rates, and promotions.

Combat probability. "Combat probability", a coded indicator of the likelihood that an MOS position is likely to face combat, is used to limit female soldiers being assigned to positions involving combat situations, a "P1" code. In the context of MOS restructuring, if new MOSs result from the merger of existing MOSs and the combat probabilities of positions in the old and new MOSs differ, this factor may constrain the scope of a restructuring to the extent that a high female content MOS may not be able to be merged into a new MOS with a large number of positions coded "P1".

Security. Security requirements, as a constraint in the MOS restructuring process, function in a manner similar to combat probability codes although the security classification itself applies to the MOS rather than positions within. If an MOS restructuring involves an MOS that is classified, that classification level must be addressed in the new MOS. MOSs with soldiers not having the required security clearances may not be able to be merged with classified MOSs.

MOS training. "MOS training" is the process which provides soldiers with a foundation of skills with which they can become

effective members of an MOS and the Army. The two main categories of MOS training are initial entry training (IET) and professional development training (PDT). IET is the introductory training given to all soldiers upon entry into the Army and includes BT and AIT. BT provides soldiers the training needed to transition from civilian to military life and furnishes them with the basic skills required of all soldiers. AIT provides soldiers with training on the job and mission critical tasks that are required for award of an MOS.

Professional development training is advanced training that provides technical and leadership courses which support career development and prepares soldiers for increasing responsibility. For the purposes of identifying MOS training constraints, only AIT will be addressed during this effort.

The major constraint in terms of MOS training is budgeted resources. Generally speaking, budget constraints can be broken down into two categories: training person years and physical training resources. Training person year requirements (TPR) are determined based on a formula that considers length of training, number of students per class, number of classes per year, and the number of weeks in a year that training can be conducted (usually 50 weeks). Training person year constraints (TPC) are provided by HQDA through a process that allocates training resources to each service school based on Army training mission priorities. Consideration is required of the resources required for training development as result of the new MOS as well as instructor demands.

The term training resources will be used here to refer to physical resources other than students and instructors such as facilities (e.g., buildings, ranges); devices; and ammunition. Facilities are both constrained and a constraining element. At the MOS training level, monies for construction and renovation of training facilities are constrained by budget. Although not a constraint in the true sense of the word, the programming process for building new facilities requires a long lead time (seven to ten years). When taken together, budget and facilities programming present a tremendous obstacle to changes in training.

The physical plant is also a constraint on training. One of the more visible impacts of physical plant is the availability of training seats. Training seats are a count of the actual spaces available for personnel to attend MOS training. This constraint is very important because it influences all other aspects of training. For example, training person years may not be constrained in terms of funding. However, if training seats are not available to support the training a constraint still exists.

Summary

Eleven MOS level MPT constraints that are critical in terms of MOS restructuring have been identified and discussed. Although not a complete list, the constraints discussed here are dominant and newly structured MOSs meeting these constraints will satisfy most regulatory guidance and policy. MCM is designed to provide procedures for identifying when these constraints must be considered in a restructuring and for establishing the constraint values.

MCM Concept

This section discusses the functional and design concepts behind the MCM. There are three subsections. First, users and uses are described; this establishes the functional requirements of the model. Second, the objectives of MCM in the MOS restructuring process are identified. The third subsection describes the model's functional elements in terms of its data requirements and constraint determination procedures.

Users and Uses

MCM is designed to be used by the CD, TD, and personnel proponent analysts in support of MOS restructuring. Although these three agencies have a wide range of programs and concerns, each must play a critical role in the MOS restructuring process. In this regard, constraints identification is a cooperative process that requires data input and analysis by all three agencies.

The basis for this cooperation is set out by the missions and functions of each agency. For example, the combat developer is responsible for determining manpower requirements; the training developer, training standards; and the personnel proponent, personnel criteria and policy. Therefore, each agency has responsibility for collecting, developing, and defending the MOS level constraints data for the MPT element under their purview.

MCM facilitates the process of establishing MPT constraints by providing procedural support, guidance for using existing data bases, and providing standard formats designed to support the MOS restructuring process. Given an MOS action, MCM can be used to identify which MPT variables are constraining, determine what the values of those constraints are, and assess the impact of those constraints in subsequent trade-off analyses.

MCM generates MOS specific data from current doctrine, policy, and HQDA data bases along with data produced from assessment of projected doctrinal and policy constraints. Through MCM, the CD, TD, and personnel proponent analysts can identify MOS level variables that are constrained. The model guides the analyst through data collection identifying the data needed and as well as the source document or data base where the data can be found.

MCM Objectives

The main objective of MCM is to provide a standard set of procedures for identifying MPT resource constraints that impact on MOS restructuring decisions. A secondary objective is to insure that existing MPT data from various doctrinal, policy, and

data bases pertaining to an MOS action are included in the analysis and evaluation of the merged MOS. By identifying constraints, the MOS analyst can define the boundaries within which restructuring options must be evaluated.

MCM Conceptual and Functional Overview

Figure 2 provides a conceptual and functional overview of MCM. As depicted, the model incorporates three functions supporting the constraint setting process: MOS constraints identification, MOS constraints estimation, and MOS constraints impact assessment.

Inputs and outputs. MCM produces as its principal output MOS level MPT constraints. These are values for any of the 11 constraining variables which need to be taken into account before approval of a restructured MOS. The values of the constraints are unique to the MOS merger action under consideration. The constraints are used in trade-off analysis and subsequent stages of the restructuring process.

The principal input into the MCM process is the notional MOS. Its characteristics and the issues related to the merger action determine the relevant constraints and subsequently the constraint values.

There are three principal data sources: policy, doctrine, and MOS MPT data bases. In general terms, the origins for these data sources may be at any organizational level in the Army from HQDA to the proponent level.

MOS constraints identification. The first function incorporated in MCM is "MOS constraints identification." Its purposes are to identify which of the 11 generic MOS constraints supported by the model must be considered in subsequent analyses and to determine the related issues. This determination is made based on the issues involved in the particular merger action and the relationship of these issues to existing policy and doctrine.

This process essentially corresponds to a problem definition phase. What MPT variables will potentially constrain the restructured MOS? The determination of which constraint variables are relevant is based on a definition, analysis, and understanding of the MPT issues associated with the merger action. Values for the relevant constraints as defined in this first procedure are determined in the subsequent process.

The result of this first set of procedures is an MOS MPT constraints subset (referred hereafter as the "MCM subset") comprising one or more of the 11 constraints which MCM addresses. Some constraints may always be included such as "authorizations."

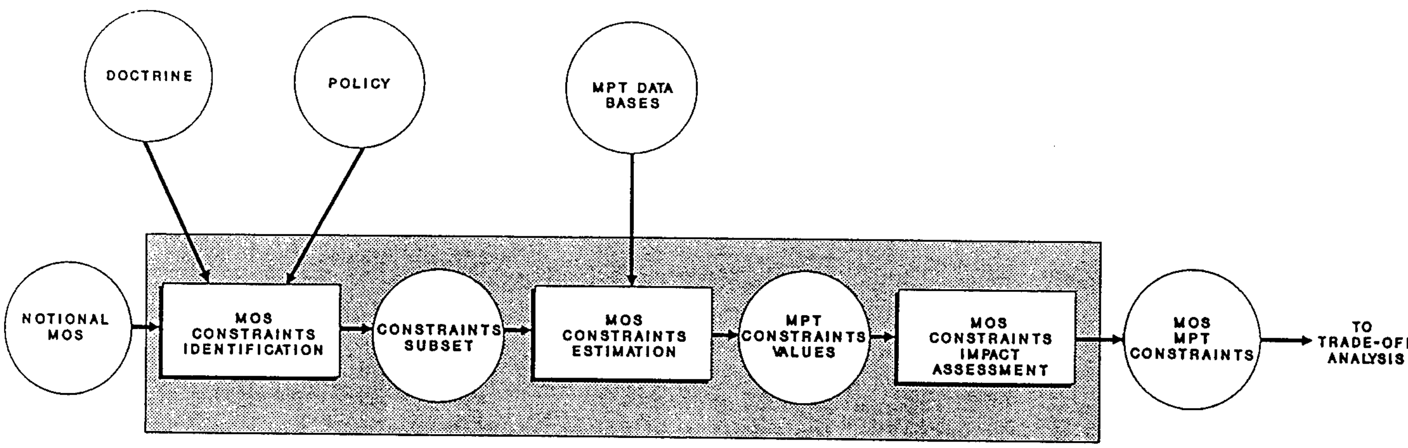

Figure 2. MCM conceptual and functional design.

Others such as "combat probability" or "security" may not necessarily be at issue.

MCM's constraints identification function consists basically of procedural guidelines which the user can follow in deciding which constraints belong in the MCM subset. For each MPT constraint, a series of questions and analytical steps will be provided which, if followed by the analyst, will support judgments regarding whether the constraint belongs in the MCM subset or not.

MOS constraints estimation. "MOS constraints estimation" is the second function in MCM. Its purpose is to assign values to each of the constraints included in the subset. To assist the user in valuing the constraints, MCM identifies data sources and describes procedures for each constraint. Where existing methods or data are lacking, guidelines are provided for setting the constraint values.

As result of this process, constraint values are set for each of the constraints included in the MCM subset. These are recorded in an MOS Constraints Table. These values become constraints during trade-off analysis and other MOS restructuring analyses.

MOS constraints impact assessment. The purpose of the final MCM step is to assess the potential impact of the MPT constraints on the notional MOS and prepare constraints input for trade-off analyses and subsequent evaluations leading to a recommended MOS structure. An MOS Constraints Issue Chart is produced. This is a listing of all MOS level variables and identification of related issues.

MCM Procedures

This section describes the procedures and identifies the sources of data required by MCM's three major functions. Use of these procedures results in the identification of constraints effecting an MOS merger and the estimation of constraint values which can subsequently be used in trade-off analysis and related MOS restructuring analyses.

As discussed in the preceding section, MCM's three major functions include: MOS constraints identification, MOS constraints estimation, and MOS constraints impact assessment. Figure 3 illustrates the MCM process in detail. Following is a discussion of each function, its component steps, and data requirements.

MOS Constraints Identification

This step in the MCM process defines the MOS restructuring action and issues under consideration, weights the importance of the various MPT constraints based on rules and policy guidance, and creates an MOS constraints subset for subsequent analysis and consideration. The step is largely procedural.

As listed in Table 2, three substeps comprise this step. Figure 4 illustrates an MOS Constraints Identification Worksheet which can be used to document the results of the three substeps comprising this process. The worksheet serves as a means for the analyst to establish an audit trail of the constraints potentially impacting an MOS restructuring and identifying the potential sources of information and rationale used to establish priorities. The data sources listed represent those most normally used.

Define MOS restructuring issues. The purpose of the first substep is to define the MPT and related issues that result from a proposed MOS restructuring. This first substep sets the tone for the subsequent steps in MCM.

The type, triggering mechanism, and scope of MOS restructuring action determines what constraint-setting rules apply, which MOS level variables may be effected, and the procedures for constraints estimation. As a general rule, there are three types of MOS restructuring actions:

1. MOS update;

2. Grade structure revision; and

3. MOS merger or consolidation.

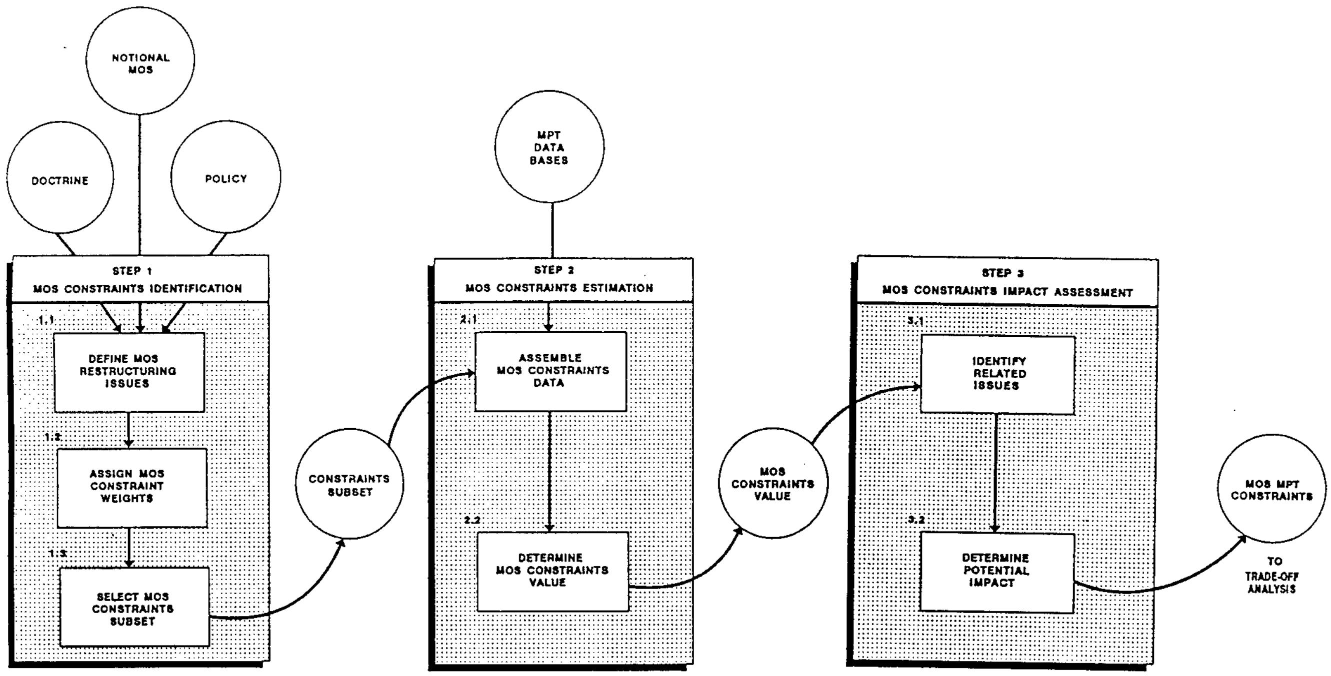

Figure 3. Detailed MCM process.

Table 2

MOS Constraints Identification Procedures

Procedures	Data Sources
1. Define MOS restructuring issues	
Identify MOSs	
Identify MOS issues (triggers, goals, expected results)	MCM Constraints List
Identify policy issues	Congressional budget guidance
2. Assign MOS constraint weights	DoD guidance and doctrine
Identify constraint policy guidance	Army regulations
Assess applicability	Army policy guidance
Assign weight	TRADOC regulations and policy
3. Select MOS constraints subset	
Determine cutoff criteria	
Select MOSs	

MOS CONSTRAINTS IDENTIFICATION

MOS CONSTRAINT SUBSET

MOS ACTION SUMMARY

SOURCE MOSs	MOS	MOS	MOS	MOS	NEW MOS
	☐	☐	☐	☐	☐

PRIORITY Enter 1-10	CONSTRAINT	SOURCES (POLICY GUIDANCE)
☐	Authorizations	☐ AR 310-49, Ch 7 ☐ AR 611-1, Ch 2 ☐ AR 611-201, Ch 1 ☐ Other ______
☐	TTHS Account	☐ MOCS Handbook ☐ Other ______
☐	Grade Structure	☐ 611-201, Ch 1 ☐ MOCS Handbook ☐ Other ______
☐	Physical Demands	☐ 611-201, Ch 1 ☐ MOCS Handbook ☐ Other ______
☐	ASVAB Scores	☐ 611-201, Ch 1 ☐ Other ______
☐	Accessions	☐ AR 601-210 ☐ Other ______
☐	Retention	☐ Other ______
☐	Combat Probability	☐ Other ______
☐	Security	☐ Other ______
☐	Training Person-Years (Developer)	☐ AR 350-10 ☐ Other ______
☐	Training Person-Years (Instructor)	☐ AR 350-10 ☐ Other ______
☐	Training Person-Years (Student)	☐ AR 350-10 ☐ Other ______
☐	Training Resources	☐ AR 350-10 ☐ Other ______

☐ Priority Cutoff Criteria

PREPARED BY:

DATE:

Figure 4. MOS Constraints Identification Worksheet.

The MOS update action is normally the least difficult of the three types of MOS restructuring actions and is the least impacted by constraints. An MOS update consists of revisions such as minor duty title changes, additions or deletions of ASIs or specialty qualification identifiers (SQIs), and minor revisions to MOS qualifications. MOS update actions do not require any significant revisions of the MOS's standards of grade authorizations (SGA) table.

An MOS grade structure revision is much more involved than an MOS update as this type of restructuring action requires changes in an MOS's SGA. This requires considerable analysis and may be impacted by several MPT constraints.

MOS mergers or consolidations consist of combining two or more MOSs into one and is the most complex of the three types of MOS actions. This type of MOS restructuring action routinely requires wholesale reorganization in how personnel in the MOSs undergoing merger are assessed, trained, fielded, and supported. See Akman and Haught (1990) and Haught and Akman (1990) for more information on MOS restructuring.

Updates, grade structure revisions, and mergers are the most common MOS restructure actions, but other actions are sometimes required. A single MOS may be subdivided into two or more MOSs, or portions of MOSs (based, perhaps, on ASIs) may be combined. An evolution in technology or revolution in doctrine might even require development of a new MOS that is neither a modification nor a merger of existing MOSs.

MOS restructuring can be triggered by a variety of events including the acquisition of new equipment, changes in training, revisions of doctrine, or organizational changes, among other catalysts. Just as the type of action influences the nature of constraints on an MOS restructuring, the triggering event does also. For instance, changes in training may directly limit the training demands of a restructured MOS. Often, new equipment must be operated and maintained by personnel with characteristics equivalent or less demanding than that required by the replacement systems.

Based on the MOSs involved, the type of action, and the triggering events, the MOS restructuring issues can be identified. These issues are subsequently used as a basis for determining which MOS MPT variables will potentially be constrained.

Assign MOS constraint weights. The purpose of the second substep is to assign weights to the 11 constraints based on the assessment of MOS restructuring issues. The weighting process is accomplished based on an understanding of the issues as well as existing policy guidance. The weighting serves as a means to

prioritize the constraints in terms of their potential impact on MOS restructuring.

The weights range from 1 to 10 where a rating of "10" signifies that the particular MPT variable must be addressed as a constraint and a "1" indicates that the variable, even if constrained, is not an issue in the restructuring. An example of an MPT variable that, under circumstances today, would almost always be rated "10" is "authorizations"; HQDA policy generally requires that the authorizations of a merged MOS cannot be greater than the authorizations associated with the MOSs being merged. "Security", on the other hand, is a variable that frequently would be weighted as a "1" since most MOSs do not have security requirements at the MOS or CMF level.

The rationale for setting weights is based on the analyst's judgment of the importance of a constraint in the MOS action. Constraints which must be addressed in accordance with clear policy mandates (e.g., required reduction in institutional training resources) should be weighted high. Those constraints for which there are little or limited policy directives would probably be weighted low unless there are issues associated with the MOS restructuring action that may require closer attention. There are also constraints which simply fall between these extremes in which case the analyst must assign a value leading to the constraint's inclusion or exclusion in the MOS constraint subset.

To make this determination, several questions about the MOS action, policies, and MOS constraints must be answered. Among these questions are:

1. Is the MOS constraint effected in any way by the restructuring action?

2. Has policy changed since the MOS or the constraint was last analyzed?

3. Does policy guidance dictate the assessment of this MOS constraint regardless of the type of restructuring action?

4. Do any policies set limitations on the constraint either in general or specific terms?

If the reply to any of these questions is "yes", then the MOS constraint should be weighted on the high side, "5" or above. If all questions can be answered "no", the variable is not constrained and may be weighted very low, essentially dropping it from further consideration. Documentation should be prepared for all MOS variables dropped. The documentation should outline the decision to drop the variable and the rationale for the decision.

The weighting process does not represent an "automatic" process; rather, the objective is to have a systematic method to choose, from among the various possible constraints, those which potentially matter the most in the restructuring.

Select MOS constraints subset. Selecting the MOS constraints subset is accomplished by defining a "priority cutoff criteria" which is some number between "1" and "10" as used in the priority ratings. The lower the cutoff number, the more constraints will be included in the subset for subsequent analysis.

The rationale for setting the cutoff value, like that for setting constraint weights, is largely procedural. A major difference in result, however, is that the analyst can create a restricted or expanded constraint subset. In this respect, the cutoff value could be set parametrically within the context of an MOS restructuring to explore alternative MOS structures as a function of constrained and non-constrained MPT scenarios.

MOS Constraints Estimation

The second step in the MCM process establishes values for each of the constraints in the subset defined in the first step. As summarized in Table 3, this is accomplished in two substeps: (1) gathering data from one or more existing MPT data bases and (2) estimating the constraint value. Table 4 identifies the existing data bases and tools, if any exist, for each MOS constraint.

Assemble MOS constraints data. In this substep, data sources are identified and data required for estimating constraint values are collected. Some of the sources from which to obtain MOS constraints data are:

1. FOOTPRINT;

2. Personnel Management Authorization Document (PMAD);

3. The Army Authorization Documents System (TAADS);

4. AR 611-201, Enlisted Career Management Fields and Military Occupational Specialties;

5. Army Training Resource Requirements System (ATRRS).

FOOTPRINT. FOOTPRINT is an automated data management tool designed to support the assessment of MPT requirements associated with a new equipment system. Although designed specifically as

Table 3

MOS Constraints Estimation Procedures

Procedures	Data Sources
1. Assemble MOS constraints data	
Select MOS constraint	
Assemble data from selected data base	FOOTPRINT
	PMAD
2. Determine MOS constraint value	TAADS
	AR 611-201
Make time differential adjustment	ATRRS
Combine MOS data	
Estimate constraint value	

Table 4

MOS Constraints Estimation Data Sources

Constraint	Data Source(s)	Tool
Authorizations	PMAD FR004 Report FOOTPRINT, Report 7 TAADS	PDAT-JA
TTHS Account	DAPC 238 Report	
Grade Structure	AR 611-201 FOOTPRINT, Report 6	Average grade distribution matrix PDAT-JA
Physical Demands	AR 611-201	
ASVAB Scores	FOOTPRINT, Reports 9,10,11,12,13	
Accessions	FOOTPRINT, Reports 9,10	
Retention	FOOTPRINT, Reports 18,19	
Combat Probability	TAADS	PDAT-JA
Security	AR 611-201	
Training	ATRRS (ARPRINT) FOOTPRINT, Reports 21,22,23,24,25,26 POIs	

an Army MANPRINT tool, FOOTPRINT is very robust and can serve as a source for gathering data on almost all MOS variables. Given its wide range of data, FOOTPRINT is the primary data source for MCM. FOOTPRINT resides on both the HQDA Decision Support System (DSS) and the TRADOC DSS, which is accessible to most, if not all TRADOC schools.

FOOTPRINT draws data from a variety of HQDA data bases and provides MPT data summaries in fixed formats based on user inputs to specific variables. Some of the data that are available include:

1. MOS Authorized and Assigned by Grade;
2. MOS Authorized CONUS versus OCONUS by Grade;
3. MOS Authorized by Standard Requirement Code;
4. ASI Authorizations by MOS and Grade;
5. Educational Profiles;
6. Reading Grade Levels;
7. Mental Category Profiles;
8. SQT Profiles;
9. Aptitude Score Profiles;
10. Aptitude and other Requirements for Initial Award of an MOS; and
11. MOS Training Courses and Graduation Rates.

As shown in Table 4, values for most of the MOS constraints can be found or derived from FOOTPRINT data.

PMAD. PMAD is a HQDA data base which uses the Department of the Army (DA) Master Force and TAADS files to document the results of force structure changes to Army personnel authorizations on a monthly basis. PMAD is the "sole source" of active Army authorizations at the unit identification code, MOS, and paygrade level of detail for current, budget, and program years. PMAD is used by the personnel community as a baseline for determining the Army's accessions, training, promotions, and distribution of personnel. For MCM, PMAD is the primary source of authorizations data.

TAADS. TAADS is a HQDA automated data base system that contains all Army units' authorization documents. The system is designed to maintain quantitative and qualitative personnel and equipment data for individual units and the entire Army force structure. The authorization document data maintained in TAADS

identify requirements and authorizations within organizational structures. Organizational data include both modified tables of organization and equipment and tables of distribution and allowances. TAADS is updated twice yearly with the first update beginning in January and the second in June. For MCM, TAADS is a source of data which can be used to address authorizations and combat probability.

AR 611-201. This regulation is a primary source of descriptive data pertaining to CMFs and MOSs. For MCM purposes, its data may be used to identify MOS physical demands and security requirements. AR 611-201 constitutes the basis for enlisted personnel management within both the active and reserve component forces. This regulation also represents a primary element in personnel, force structure, and organization management by specifying the standards of grade authorization that will be used to grade enlisted personnel position requirements and authorizations in Army authorization documents.

In addition to defining enlisted personnel positions, AR 611-201 also details the current approved listing of enlisted CMFs and MOSs. This listing provides a narrative description of each CMF including MOS content, variety of duties, mental and physical qualification requirements, and career objectives. The path for each MOS is specified by skill level from initial entry paygrades through Command Sergeants Major.

ATRRS. ATRRS is one source from which to assemble training constraints data. It contains the total "raw" training requirements needed to support AIT, officer and enlisted professional development, reenlistment or reclassification programs, along with other training mission requirements.

A principal component of ATRRS is the Army Program for Individual Training (ARPRINT). ARPRINT identifies by fiscal year, projected individual training programs for established Army training including all MOS producing courses. Included in the ARPRINT are course title, applicable MOS, prerequisites for training, length of training, capacity (number of training seats), frequency of training, and location.

Determine MOS constraints value. For each MOS constraint variable included in the subset, constraint values must be determined. This is generally accomplished by adjusting the raw data from one or a combination of the existing MPT data bases to represent the constraint. The adjustments are required generally for two reasons: (1) to translate current year data to some future year when the MOS restructuring will actually occur and (2) combining data for two or more MOSs in order to represent the constraints associated with the new, merged MOS. In both instances, the adjustments are the result of relatively simple

arithmetic processes combined, at times, with careful value judgments. Figure 5 illustrates an MOS Constraints Table which is used to record constraint values. Prototype procedures for determining five of the constraint values are illustrated in Appendix A.

Adjustments for time differentials. If data are not available for the implementation year of a proposed restructuring action, then data for the current or other year must be used as a baseline for projecting values for the MOS constraint. In addition to the baseline data, adjustment factors must be determined. These adjustment factors may be based on historical trends adjusted for current and future events; SMEs may be needed to verify values of the adjustment factors.

Combining data of multiple MOSs. Besides adjusting for the time differential to a common reference year, if there are data from more than one MOS, these data must be combined to represent constraints for the merged MOS. This combination generally will either involve a simple summation of individual MOS data, such as authorizations, or averaging, such as accession or retention rates.

MOS Constraints Impact Assessment

The purpose of the final step in the MCM process is to identify MOS issues related to the constraints. The objective is to provide context to the constraint values by developing additional information identifying related issues and potential impacts associated with the individual constraints as well as the entire constraint subset. Table 5 lists the procedural steps. An MOS Constraints Issues Chart, similar in format to the MOS Constraints Table, is used to document the results of this process.

Identify related issues. When constraints do exist and have been defined, there may be related issues beyond the values of the constraints that should be considered in the course of MOS restructuring. Table 6 provides a basic list which the MCM user may use as reference in identifying constraint issues for each MPT variable included in the subset. In addition to those included in the table, there will likely be other issues that are unique to a particular MOS restructuring.

Authorizations. Two likely issues to arise when authorizations are constrained in a restructuring relate to the "change in authorizations" and "transition requirements". Generally, existing HQDA policy requires that authorizations for restructured MOSs not be greater than existing authorizations for

MOS CONSTRAINTS ESTIMATION

MOS CONSTRAINTS TABLE

Authorizations	E3	E4	E5	E6	E7	E8	E9	TOTAL

THHS Account	FY	

Grade Structure		E3	E4	E5	E6	E7	E8	E9	TOTAL
	Current								
	AGM								
	Delta								

Physical Demands								
ASVAB Scores	AA	AA						
Accessions	FY	FY	FY	FY	FY	FY	FY	
Retention	FY	FY	FY	FY	FY	FY	FY	
Combat Probability								
Security								
Training Person-Years (Developer)								
Training Person-Years (Instructor)								
Training Person-Years (Student)								
Training Resources								

NOTES

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DATE:

Figure 5. MOS Constraints Estimation Worksheet.

Table 5

MOS Constraints Impact Assessment

Procedures	Data Sources
1. Identify related issues Review policy guidance and related information Determine related issues 2. Assess potential impact Review issues for each constraint Assess impact on MOS constraint subset	MOS constraints values Congressional budget guidance Army regulations Army policy guidance TRADOC regulations and policy

Table 6

Related Issues

Constraint	Related Issue
Authorizations	Change in authorizations Transition requirements Mission requirements Personnel impact
TTHS	Composition of TTHS Trainee and Student populations MOS fill requirements
Grade structure	Grade changes Grade structure conflicts Transition requirements Mission requirements Career progression
Physical demands	Job performance impact Equipment redesign Recruitment impacts Women in the Army impacts
ASVAB scores	Job performance impact Equipment redesign Recruitment impacts Training impacts
Accessions	Change in accessions Transition requirements Incentives
Retention	Change in retention Force structure impacts Incentives
Combat probability	Women in the Army issues
Security	Personnel impact MOS accessions
Training	Training resource impact Training type Transition requirements MOS fill requirements

the MOSs being changed. The authorization level in the year that the restructuring will occur, although it may be fixed, may be different than the currently existing authorizations for the individual MOSs. The changes in this level from the current baseline should be considered along with the authorizations constraint.

A second issue is the transition requirement. If the restructured authorizations differ from the baseline, there may be training or personnel requirements which must be addressed in order to meet the authorizations level. More or less training or changes in accession or retention policies, among other considerations, may be required in order to deal with the authorizations constraint in restructuring MOSs.

TTHS. When TTHS is constrained in the course of MOS restructuring, consideration may have to focus on the composition of the TTHS account, particularly trainees and students. While TTHS represents a personnel overhead accounting method which is directly derived from authorizations, changes to MOSs as a result of restructuring may have impact on the TTHS account and its composition. To the extent a restructuring effects changes in the MOS fill rate and training duration requirements, the TTHS account may be impacted. For example, if there is significant displacement among incumbent MOS holders leading to job vacancies and additional training requirements, TTHS will be forced higher.

Grade structure. With respect to grade structure, both "grade changes" and "transition requirements", like similar issues arising with respect to authorizations, may require consideration. When a restructuring occurs, the MOS positions must be graded correctly. The current grades may have deviated from existing standards of grade. Consequently, not only must grade requirements stemming from HQDA policy be met but existing grading may have to be brought back in line to meet this requirement.

In addition, there well may be "grade structure conflicts", particularly when two or more MOSs are being merged. The source MOSs may have had significantly different grade structures which cannot be combined without incompatibilities arising and disruptions imposed on normal "career progression".

Physical demands. When restructuring occurs, new physical demands standards may have to be defined. Since the source MOSs may have had different requirements, which standard is adopted? A less demanding standard may mean more of the former MOS's tasks can be performed by all MOS holders. A more demanding standard may result in existing MOS holders, particularly females, being unable to perform in the new MOS. Job productivity will be

effected. Issues related to equipment design and recruitment arise. Requirements for ASIs may result.

ASVAB. Issues similar to those discussed with respect to physical demands may arise with ASVAB requirements when a restructuring occurs. Job performance impacts, equipment design, and recruitment requirements may emerge as issues when the ASVAB requirements change. Changes in ASVAB requirements may also significantly effect training changes if they are not accommodated (e.g., if the ASVAB entry score is not raised when it should be, then the training attrition rates may increase). Also, if the ASVAB entry score requirements are raised for a large MOS then the branch's distribution of quality will be affected and a bill payer may need to be found.

Accessions. When MOSs are restructured, historical or existing accession patterns may no longer continue. Consequently, in addition to the accession rates constraining the restructured MOS, changes in the accession patterns may also occur. For example, a restructured MOS may have greater or lesser appeal causing different career choices to be made. These changed patterns may be countered with incentives. Further, transitional issues may arise if significant changes in these patterns occur.

Retention. Potential related issues associated with retention are similar to those discussed above with respect to accessions. Additionally, there may be force structure issues as well if retention patterns change.

Combat probability. If combat probability is a constraint, the issue of women's roles in the Army will arise. There may be limitations in the roles female soldiers can play. These limitations will become issues in a restructuring whenever combat probability is a constraint.

Security. When an MOS restructuring occurs as result of MOS mergers and a security requirement, not common among all source MOSs, remains, decisions need to be made with respect to implementing this requirement into the new MOS. Extending the requirement to all members of the MOS may be costly and unnecessary. For example, security requirements may restrict accessions to a smaller, higher qualified group and effect the Army's ability to fill the new MOS.

Training. The training establishment involves many different resources among which are instructors and students, training devices, and training facilities. These are often constrained. When restructuring occurs and the training requirements increase, but training factors are constrained, many issues arise regarding the training resource impact and changes in unconstrained training elements in order to meet the training constraints. Also, as training requirements increase and

soldiers spend more time training, the unit fill requirements may not be met unless the authorization ceiling is raised.

Determine potential impact. The second substep is to determine potential impacts associated with the constraints and issues which have been identified. This information is used throughout the restructuring process as new MOSs are formulated. While the constraints must be met in order to arrive at successful restructuring proposals, understanding related issues and their impact provides guidelines for manipulating the task and MPT characteristics of the new MOSs.

Sample MCM Application: Merger of MOS 12B and 12C

This section presents a sample application of the MCM to a theoretical consolidation of MOS 12B, Combat Engineer, and MOS 12C, Bridge Crewman. The results of step-by-step data collection and analysis procedures are discussed and constraint determinations made. Most of the data are derived from FOOTPRINT. The specific procedures are documented in the appendix.

This sample application deals with determining MOS level constraints on a merged MOS in terms of the Active Army only. In order to determine constraints for the total force, the procedures presented in this section should also be applied to Reserve Component and National Guard as well. The following example was developed to illustrate how constraint variables documentation might appear. Since they are samples, the references used and rules developed may not be fully representative.

Step 1: MOS Constraints Identification

The first step in applying MCM is determining which of the MOS constraint variables require consideration as constraints in the merger action. MOSs 12B and 12C were analyzed for commonality using the Task Commonality Analysis Method (TCAM) (see Haught and Enwright (1990) to determine the efficacy of merging the two MOSs into a single MOS. The results of this analysis indicated that task and knowledge requirements for these two MOSs were almost identical with exception of six tasks (three 12B and three 12C) that required knowledges specific to each MOS.

These results indicated that the MOSs could be considered for merger into a single MOS which would essentially combine combat engineering and bridging functions. The notional MOS given to this new function is MOS 12A, Combat Engineering and Bridging. Based on this background, MCM was used to identify the MOS level variables that are constrained. The results of this analysis are summarized in Figure 6, which shows a sample version of the MOS Constraints Identification Worksheet.

Five variables were singled out as constraints for consideration in this merger action: authorizations, grade structure, ASVAB scores, accessions, and training. The rationale and basis for these choices are explained below.

Authorizations. Numerous sources of policy guidance dictate constraints on authorizations in an MOS merger. AR 310-49 requires that aggregate MOS authorizations for MOS 12B and MOS 12C not be increased or decreased solely as result of the merger action. Further constraining are the requirements stemming from AR 611-1 and AR 611-201 that the aggregate total of merged MOS

MOS CONSTRAINTS IDENTIFICATION

MOS CONSTRAINT SUBSET

MOS ACTION SUMMARY

SOURCE MOSs	MOS	MOS	MOS	MOS	NEW MOS
	12B	12C			12A

Create new MOS 12A: Combat Engineering and Bridging

PRIORITY Enter 1-10	CONSTRAINT	SOURCES (POLICY GUIDANCE)
10	Authorizations	☑ AR 310-49, Ch 7 ☑ AR 611-1, Ch 2 ☑ AR 611-201, Ch 1 ☑ Other Reduction in Force, Base Closures
3	TTHS Account	☐ MOCS Handbook ☐ Other
10	Grade Structure	☑ 611-201, Ch 1 ☑ MOCS Handbook ☐ Other
3	Physical Demands	☐ 611-201, Ch 1 ☐ MOCS Handbook ☐ Other
7	ASVAB Scores	☑ 611-201, Ch 1 ☑ Other HQDA policy
7	Accessions	☑ AR 601-210 ☑ Other AR 611-201, AR 600-200
3	Retention	☐ Other
3	Combat Probability	☐ Other
1	Security	☐ Other
3	Training Person-Years (Developer)	☐ AR 350-10 ☐ Other
3	Training Person-Years (Instructor)	☐ AR 350-10 ☐ Other
10	Training Person-Years (Student)	☑ AR 350-10 ☐ Other
3	Training Resources	☐ AR 350-10 ☐ Other
5	Priority Cutoff Criteria	

PREPARED BY: D. Haught

DATE: 09/15/91

Figure 6. Sample MOS Constraints Identification Worksheet.

authorizations will not exceed those separately allocated to the source MOSs through the Program Budget and Guidance for the program year the merger will be implemented. Examination of the operational and organizational concept for the new engineer vehicle shows that reductions in crew size are expected as result of the introduction of the new equipment. HQDA policies related to decreases in authorizations resulting from base closures and the Army force reduction must be addressed in this merger action. Consequently, "authorizations" has been rated as a "10".

Grade structure. Grade structure, in accordance with HQDA policy, must conform to the average grade distribution matrix. Based on a review of AR 611-201, existing grade structures for MOS 12B and MOS 12C are significantly different due to the size of the MOSs and the respective roles each has had. The merger of these may potentially pose problems from a grade structure perspective initially after implementation. Since HQDA policy clearly identifies grade structure requirements which must be met by an MOS, "grade structure" is rated as a "10".

ASVAB scores. HQDA policy requires that the AA scores cannot be increased without a trade-off. If AA scores are increased for one MOS in a CMF, a like reduction must come from another MOS. The ASVAB implications of this merger action need to examined to determine if there is an effect. Because the MCM analyst does not expect this to be an issue but knows that this variable must be addressed explicitly, a priority rating of "7" is given.

Accessions. Because of HQDA reduction in force policies, the current combined accession rate of MOS 12B and MOS 12C may lead to MOS overfill conditions in a merger. Consequently, constraints on MOS 12A accessions need to be identified and considered as a factor during MOS restructuring analysis. "Accessions" is rated a "7" on the worksheet.

Training. Generally, because of the significant resource demands for people and equipment required for training and the limitations in budget resources, HQDA policy requires that the training demands of new MOSs be met within specific resource constraints. While numbers of students and instructors are issues as well as physical training resources, often the "length of training" or "training load" as measured by student person years can serve as suitable proxies at this stage of analysis. The worksheet shows a "10" rating for "training person years (students)"; training will be addressed within the constraint setting process as well as throughout the MOS restructuring process.

Low priority constraint variables. A variety of different reasons has led to low priority ratings for the other MOS variables in this example. Requirements for "physical demands" for both the existing MOSs as well as the new MOS are the same

and not expected to change. There is no "security" requirement. The source MOSs and merged MOS are all rated as "combat probability" P1. "Instructor training person years", determined by a TRADOC manpower standard for instructors (see AR 570-5) and other variables, will be consistent with current training requirements as a result of other training variables being constrained and addressed in this analysis.

Setting the "priority cutoff criteria". The cutoff criteria can be set high or low depending on the range of constraints the analyst feels needs to be considered. For this example, "5" was chosen. This results in the five MOS variables discussed above being selected for analysis and assessment in MCM's subsequent steps.

Step 2: MOS Constraints Estimation

Constraints were estimated for the five MOS level variables identified as constraints for consideration during the merger of MOSs 12B and 12C into MOS 12A. Figure 7 provides a sample version of the MOS Constraints Table and displays the results of the constraints estimation. The estimated value of each constraint is discussed below. Procedural descriptions of the computations and analysis required for estimating the values for the five constrained variables are provided in the appendix.

Authorizations. The notional MOS authorizations constraint for MOS 12A is 11,886. This is based on current MOS 12B and MOS 12C authorizations, reductions of over 2,500 MOS positions between the current fiscal year (FY) and the FY MOS 12A is to be implemented due to reductions in force, and adjustments resulting from base closures.

Grade structure. To determine the grade structure constraint, the Army's average grade distribution matrix (AGM) was applied to the notional MOS 12A authorizations. The results of this application indicated that grades E4, E5, E6, and E7 would increase with a corresponding decrease to the E3 grade content.

Generally, application of the AGM defines the grade distribution constraint. However, as shown in the table, application of the AGM to the notional MOS 12A increases the top paygrades (E5, E6, and E7) in excess of the combined top paygrades for MOS 12B and MOS 12C. One of the rules in MOS restructuring is that "the number of soldiers in existing senior grades (E5 through E9) cannot be increased without offsetting reductions from another MOS within the CMF". Consequently, the grade structure constraint in this example winds up being defined by the MOS 12A authorizations constraint instead of the AGM distribution.

	MOS CONSTRAINTS ESTIMATION MOS CONSTRAINTS TABLE	

		E3	E4	E5	E6	E7	E8	E9	TOTAL
Authorizations		3152	3710	2410	1601	1013			11886
THHS Account		FY							
Grade Structure		E3	E4	E5	E6	E7	E8	E9	TOTAL
	Current	3152	3710	2410	1601	1013			11886
	AGM	2841	3904	2432	1668	1041			11886
	Delta	↓311	↑194	↑22	↑67	↑28			
Physical Demands									
ASVAB Scores		AA	AA						
		C090							
Accessions		FY 92	FY 93	FY 94	FY 95	FY	FY	FY	
		2,730	2,730	2,730	3,145				
Retention		FY	FY	FY	FY	FY	FY	FY	
Combat Probability									
Security									
Training Person-Years (Developer)									
Training Person-Years (Instructor)									
Training Person-Years (Student)		231							
Training Resources									

NOTES

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DATE: 09/15/91

Figure 7. Sample MOS Constraints Table.

ASVAB scores. Both MOS 12B and MOS 12C require an ASVAB entry score of CO = 90. Thus, the ASVAB score constraint for the notional MOS 12A is 90 in Aptitude Area CO since no tasks requiring higher scores are being added to 12A. Policy generally requires that there be no increased aptitude requirements stemming from an MOS restructuring. In this case, the constraint corresponds to the existing requirement so there is no problem.

Accessions. The MOS 12A accessions constraint ranges from 2,720 to 3,145 personnel a year for FY 92 through FY 95. These numbers represent lower accessions than the combined MOS 12B and MOS 12C FOOTPRINT data in order to reflect (1) reductions in force and (2) overfill conditions in the initial years.

Training. The training constraint is measured in terms of the student training person years (TPY) available for training. TPY is based on (1) the projected number of students for the year in which the notional MOS will be implemented, and (2) the current length of training for the MOSs to be merged. The TPY was computed based on the combined TPY of MOSs 12B and 12C which resulted in 231 student TPY. Please note that if accessions during the implementation year were expected to be equivalent to current accession rates, then the TPY constraint would have computed to a much higher value, 308. By taking accession rates into account, a more restrictive -- and more realistic -- training constraint is imposed.

Step 3: MOS Constraints Impact Assessment

The final step in applying MCM is identifying and assessing issues that are related to the MOS constraints. In this process, each constraint is analyzed to determine the possible impacts on the notional MOS. Figure 8 presents a sample version of a MOS Constraints Issues Chart. Reflected on the chart are the constrained MOS variables for MOS 12A and the issues related to each constraint that may impact the restructured MOS.

Authorizations. The reduction of over 2,500 authorizations for notional MOS 12A will create an overstrength situation in terms of MOS incumbents. The personnel overstrength may in turn cause other personnel issues to evolve over time. Among these are (1) mandatory personnel reclassification, (2) decreased MOS accessions, and (3) decreased MOS retention. Other issues such as forced retirements may also arise. On the surface, these may not seem overly significant issues. However, if not monitored closely, any one of these issues can create tremendous personnel turbulence resulting in uncontrolled personnel loss.

Grade structure. Notional MOS 12A's grade structure constraint presents several potential operational problems. Application of the AGM to this notional MOS suggests increases in senior grade content (E5, E6, and E7) to enhance the viability of the MOS from a mission effectiveness and personnel standpoint. However,

MOS CONSTRAINTS IMPACT ASSESSMENT

MOS CONSTRAINTS ISSUES CHART

Authorizations	Creates personnel overstrength Requires reclassification
THHS Account	
Grade Structure	Decreases career progression Decreases promotion potential
Physical Demands	
ASVAB Scores	No impact
Accessions	May cause MOS fill shortages in outyears because of near term decreases
Retention	
Combat Probability	
Security	
Training Person-Years (Developer)	
Training Person-Years (Instructor)	
Training Person-Years (Student)	Notional required training may exceed TPY constraint due to unique 12B and 12C tasks
Training Resources	

NOTES

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DATE: 09/15/91

Figure 8. MOS Constraints Issues Chart.

notional MOS 12A is constrained to the grade structure that is currently documented unless one-for-one grade trade-offs can be found.

Issues related to this constraint may include career progression and promotion potential. Lack of career progression and promotion potential may require personnel who are otherwise qualified to be forced out of the Army because they exceed grade and time in service requirements (up or out). The Army may also experience fill problems resulting from increased MOS loss resulting from inadequate career progression.

ASVAB scores. The ASVAB score for notional MOS 12A was not changed from what is currently required. Therefore, no related issues are identified for this constraint.

Accessions. Accessions for notional MOS 12A are constrained because of force structure reductions. An issue to be addressed here is the additional near-term decrease in accessions resulting from the need to reduce current overages in MOS operating strength. Accessions for MOS 12A were reduced an additional 414 personnel per year to compensate for the overage. This additional reduction may cause MOS fill shortages at grades E5 and E6 in the outyears because an adequate number of qualified personnel may not exist to fill the requirements. This issue should be monitored closely and accessions adjusted if outyear shortages appear likely.

Training. The constraint on the student TPY for notional MOS 12A may preclude the accomplishment of adequate training. In determining the training length for each source MOS, it was observed that significant training hours are required for tasks unique to each MOS. This will result in a notional training course length which exceeds the length of either of the current courses. Hence, the TPY constraint is likely to be exceeded unless, during trade-off analysis, certain tasks are eliminated from the notional MOS or the student load can be reduced below the combined MOS 12B and 12C level. Note that if training duration for the new MOS is increased, then the unit fill rate of skill level one soldiers will be reduced. If additional training cannot be accomplished, then the mission effectiveness of both MOS 12A soldiers and units in which they are required will be unfavorably affected.

Future Directions

This report has presented and demonstrated design concepts for a constraint-setting method in support of MOS restructuring. MCM consists of procedures for identifying constraints, estimating their values, and assessing their impacts on MOS restructuring. There is significant reliance on existing Army data bases, particularly the HQDA FOOTPRINT DSS, which can serve as a gateway to most Army data bases required by MCM.

MCM has a role in the Army's MOS restructuring decision support technology. Based on its present conceptual definition, the focus of future efforts should be on formalizing and proceduralizing MCM so that it is an accessible tool available to the combat developers, training developers, and personnel proponents engaged in MOS restructuring. Its operational form may either be paper- or computer-based, the choice depending upon resources and the overall technological approach underlying the Army's MOS restructuring decision support technology.

References

Akman, A. & Haught, D. (1990). Review and analysis of the military occupational specialty (MOS) restructuring problem. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0002, Research Note.

Headquarters, Department of the Army. The Army Authorization Documents System (TAADS). Army Regulation 310-49. Washington, D.C.: Headquarters, Department of the Army. 1980.

Headquarters, Department of the Army. Management of Army Individual Training Requirements and Resources. Army Regulation 350-10. Washington, D.C.: Headquarters, Department of the Army. 1990.

Headquarters, Department of the Army. Manpower Staffing Standards Program. Army Regulation 570-5. Washington, D.C.: Headquarters, Department of the Army.

Headquarters, Department of the Army. Enlisted Personnel Management System. Army Regulation 600-200. Washington, D.C.: Headquarters, Department of the Army. 1988.

Headquarters, Department of the Army. Regular Army and Army Reserve Enlistment Program. Army Regulation 601-210. Washington, D.C.: Headquarters, Department of the Army.

Headquarters, Department of the Army. Military Occupational Classification Structure and Implementation. Army Regulation 611-1. Washington, D.C.: Headquarters, Department of the Army. 1989.

Headquarters, Department of the Army. Enlisted Career Management Fields and Military Occupational Specialties. Army Regulation 611-201. Washington, D.C.: Headquarters, Department of the Army. 1989.

Haught, D., Akman, A., & Finley, D. (1990). Requirements-based restructuring of Army military occupational specialties. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0002, Research Note.

Haught, D. & Enwright, J. (1990). Battlefield maintenance case study: Task commonality analysis for system maintenance requirements. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0003, Research Product.

Haught, D., Schniebolk, R., & Akman, A. (1991). <u>Position data analysis job aid prototype software user's manual</u>. Silver Spring, MD: Akman Associates, Inc., Contract No. F49642-88-D-0003 5026.

Steinbach, C., Akman, A., & Haught, D. (1990). <u>Military occupational specialty (MOS) restructuring research and development blueprint</u>. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0003.

Acronyms

AA	Aptitude Areas
AFQT . . .	Armed Forces Qualification Test
AGM	Average Grade Distribution Matrix
AIT	Advanced Individual Training
AR	Army Regulation
ASI	Additional Skill Identifiers
ASVAB . . .	Armed Services Vocational Aptitude Battery
ATRRS . . .	Army Training Resource Requirements System
BT	Basic Training
CD	Combat Developer
CMF	Career Management Field
CO	Combat
DA	Department of the Army
DAPC . . .	Department of the Army Personnel Command
DOD	Department of Defense
DCSPI . . .	Deputy Chief of Staff Personnel Integration
DSS	Decision Support System
ETS	Elapsed Time in Service
FY	Fiscal Year
GSA	Grade Structure Analysis
HQDA . . .	Headquarters Department of the Army
IET	Initial Entry Training
MACOM . . .	Major Army Commands
MCM	MOS Constraints Model
MOS	Military Occupational Specialty
MPT	Manpower, Personnel, and Training
PDT	Professional Development Training
PDAT-JA . .	Position Data Analysis Job Aid
PMAD . . .	Personnel Management Authorization Document
SC	Surveillance and Communications
SGA	Standards of Grade Authorizations
SQI	Specialty Qualification Identifier
TAADS . . .	The Army Authorization Documents System
TAD	Target Audience Description
TD	Training Developer
TOE	Table of Organization and Equipment
TPC	Training Person Year Constraints

TPR	Training Person Year Requirements
TPY	Training Person Years
TRADOC . .	Training and Doctrine Command
TTHS . . .	Trainees, Transients, Holdees, and Students

APPENDIX A

CONSTRAINT ESTIMATION PROCEDURES

Appendix A

Constraint Estimation Procedures

Following are procedural descriptions of the computational and analytical processes used for estimating values for the five MOS constraints addressed in the MOS 12B and MOS 12C example. While specific to this scenario, these procedures would have general applicability for constraint setting for other MOS restructuring actions although specific details may differ based on particular MOSs and issues.

Procedure 1: Authorizations

Purpose: Calculate authorizations constraint for notional MOS

Data Source: PMAD FR004 report for each MOS undergoing analysis

Resources: Calculator or spreadsheet

Procedures (6 steps):

Step 1. Select the "Current" FY MOS authorizations column on the PMAD FR004 report as the source of data for the first step of this process. Record the authorizations of the MOSs to be merged by grade and total the two as shown in the example below. The total of the merged MOSs will become the authorizations baseline for the notional MOS.

NOTIONAL MOS AUTHORIZATIONS BASELINE

MOS	E3	E4	E5	E6	E7	TOTAL
MOS 12B	3,720	3,093	2,207	1,731	929	12,490
MOS 12C	474	725	532	184	118	2,033
MOS 12A	4,194	4,628	2,739	1,915	1,047	14,523

Step 2. Find the column on the FR004 report that corresponds to the "FY" in which the new MOS is scheduled to be implemented. Using the by-grade breakout of authorizations for each MOS, and total them as shown below. This set of data becomes the projected notional MOS authorizations.

PROJECTED NOTIONAL MOS AUTHORIZATIONS CONSTRAINT

MOS	E3	E4	E5	E6	E7	TOTAL
MOS 12B	2,850	3,013	1,914	1,431	920	10,128
MOS 12C	402	700	500	180	113	1,895
MOS 12A	3,252	3,713	2,414	1,611	1,033	12,023

Step 3. Review the Army guidance pertaining to MOS authorizations. Determine if the MOS authorizations that are programmed for the implementation year are reflective of all constraints. This can be accomplished by calling the U.S. Army Deputy Chief of Staff Personnel Integration, Force Personnel Requirements Division ((301) 325-0393) and talking to the Force Development Officer responsible for the MOSs at issue. Through discussion, a determination can be

made if all constraints are reflected in the MOS authorizations that are programmed in PMAD for a particular FY. Any constraint that is not reflected in the PMAD authorization will require manual input. If all constraints are reflected in these data, the projected notional MOS authorizations becomes the constraint.

Step 4. If required, change the MOS authorizations to reflect constraints that have not yet been captured in PMAD. When performing this step be sure to document whether the change is an increase or a decrease and the reason for the change. See the example below.

NOTIONAL MOS AUTHORIZATIONS CONSTRAINT

MOS	E3	E4	E5	E6	E7	TOTAL
MOS 12A (Step 2)	3,252	3,713	2,414	1,611	1,033	12,023
Decrease	-100	-3	-4	-10	-20	137
Constraint	3,152	3,710	2,410	1,601	1,013	11,866

Reason: PMAD data were adjusted to reflect the decrease in MOS authorizations because of base realignment and closure requirements. This action was discussed with DCSPI resulting in their concurrence to change the data.

Step 5. Determine the net change in MOS authorizations. This is accomplished by comparing the by-grade totals of the "current" notional MOS authorizations to the notional MOS authorizations constraint as depicted in the sample below.

When using the results of this analysis, use the data developed in Step 2 if Step 4 was not required. If Step 4 was completed, use the Step 4 data instead.

NOTIONAL MOS AUTHORIZATIONS NET CHANGE

MOS	E3	E4	E5	E6	E7	TOTAL
Baseline (Step 1)	4,194	4,628	2,739	1,915	1,047	14,523
Constraint (Step 4)	3,152	3,710	2,410	1,601	1,013	11,886
Net Change	-1,042	-918	-329	-314	-35	-2,637

NOTE: The data developed in this step will be required in subsequent steps of MCM for determining constraints on other MOS variables.

Procedure 2: Grade structure

Purpose: Determine grade structure constraints for notional MOS

Data Source: Notional MOS authorizations constraint (from Procedure 1)

Resources: PDAT-JA's Grade Structure Analysis (GSA) Capability; or

Average Grade Distribution Matrix (AGM) in the MOCS Handbook; calculator or spreadsheet

Procedures (3 steps):

Step 1. Transfer from Procedure 1 the notional MOS authorizations constraint by-grade to a separate sheet of paper. Use the following example for this procedure.

NOTIONAL MOS AUTHORIZATIONS CONSTRAINT

	E3	E4	E5	E6	E7	TOTAL
MOS 12A Authorizations Constraint	3,152	3,710	2,410	1,601	1,013	11,886

Step 2. Apply the AGM to the notional MOS authorizations constraint either by using the table and instructions contained in the MOCS Handbook or use the automated GSA capability of PDAT-JA. The PDAT-JA Users Manual provides directions on how to perform this task. Annotate the by-grade results of the AGM application under the corresponding grade cell of the notional MOS and determine the delta between the two. See the example below.

MOS GRADE STRUCTURE

	E3	E4	E5	E6	E7	TOTAL
MOS 12A Authorizations Constraint	3,152	3,710	2,410	1,601	1,013	11,886
AGM	2,841	3,904	2,432	1,668	1,041	11,886
Delta	↓311	↑194	↑22	↑67	↑28	0

Step 3. Determine the MOS grade structure constraint. Normally the average grade distribution is the major constraining factor in terms of grade structure. However, as shown in the example, application of the

AGM to notional MOS 12A would increase the authorizations for paygrades E5, E6, and E7. One of the rules in MOS restructuring is "senior grades (E5 through E9) cannot be increased without a suitable trade-off." For every increase in these paygrades, a like decrease (e.g., one E7 grade for one E7 grade) must come from another MOS within the CMF. Therefore, the grade structure constraint is what has been documented as the notional MOS authorizations constraint rather than that created by the application of the AGM.

	MOS GRADE STRUCTURE CONSTRAINT					
	E3	E4	E5	E6	E7	TOTAL
MOS 12A	3,152	3,710	2,410	1,601	1,013	11,886

Procedure 3: ASVAB scores

Purpose: Determine ASVAB constraint

Data Source: FOOTPRINT Report 21 for each MOS under consideration for merger

Resources: Pencil and paper

Procedure:

Step 1. Find the Aptitude Area (AA) score requirements for the MOSs to be merged on FOOTPRINT Report 21. Annotate these numbers as shown below.

ASVAB (AA) SCORE REQUIREMENTS

$$AA_{12B} = 90\ CO$$

$$AA_{12C} = 90\ CO$$

AA scores cannot be increased without a trade-off. If AA scores are increased for one MOS within the CMF a like reduction must come from another MOS within the CMF.

If Aptitude Area scores differ such as the CO score for one MOS is 90 and 85 for the other, then the lowest number for the MOSs becomes the constraint unless there are bill payers or the MOS with the requirement for 85 is relatively much smaller in number of authorizations.

Additionally, different AA categories may be required of the merged MOSs. For example, an MOS may require an AA score in the category CO while the other requires an AA score in the category of ST. An analysis must be performed to determine which AA area score takes precedence over the other. If it is determined both are required, than an exception to policy request must be forwarded to HQDA with justification for this requirement.

ASVAB SCORE CONSTRAINT (AA)

$$\begin{aligned} AA &= \text{MINIMUM } (AA_{MOS}) \\ &= \text{MINIMUM } (AA_{12B}, AA_{12C}) \\ &= \text{MINIMUM } (90\ CO, 90\ CO) \\ &= 90\ CO \end{aligned}$$

Procedure 4: Accessions

Purpose: Determine accessions constraint for notional MOS

Data Sources: FOOTPRINT Target Audience Description (TAD) and Baseline MOS Description; FOOTPRINT Reports 4, 10, 11, and 21 for all MOSs considered for merger

Notional MOS authorizations constraint (Procedure 1)

Resources: Calculator or spreadsheet

Procedures (5 steps):

Step 1. Determine the combined average of the current MOS loss rates for the MOSs being merged due to elapsed time in service (ETS). Use FOOTPRINT Report 10 for this process. Add the retention percentages for the past three "FY" and divide by "3"; then subtract that number from "1". The result of this process provides the combined average loss rate for the notional MOS. See the example below.

COMBINED AVERAGE LOSS RATE

	FY 88		FY 89		FY 90						
MOS 12B	.78	+	.86	+	.79	=	2.43	÷	3	=	.81
MOS 12C	.94	+	.76	+	.81	=	2.51	÷	3	=	.84
	.81	+	.84	=	1.65	÷	2	=	.83		

ETS = 1 - .83 = .17 or 17%

LOSS RATE = ETS + OTHER
= 17% + 2% = 19%

Next, add "Other Loss" which is the term used for MOS losses that are not due to ETS. Included in this category are losses due to discharges other than ETS, confinement, deaths, reenlistment for a different MOS, reclassification, etc. There are no hard and fast rules for determining this loss but a good rule-of-thumb is approximately 2% of the MOS. Therefore, this figure needs to be added to the ETS loss figure to determine the MOS loss rate. The result of this process is the average loss rate for the notional MOS. Determine the total loss rate by adding together the ETS loss for MOSs (17%) and the rate for other loss (2%). The total loss rate for notional MOS 12A is 19%.

Step 2. Determine the average percent of fill for the combined MOSs. Use the FOOTPRINT TAD for each MOS considered in this merger. Transfer the percentage data on the "Current Inventory" and "Projected Force Structure" for the current MOSs as depicted below and total the numbers for all grades.

	E3	E4	E5	E6	E7	TOTAL
MOS 12B	116.5	86.2	102.0	96.0	93.0	493.7
MOS 12C	151.8	63.8	81.1	95.2	96.0	487.9

Next, divide the totals for each MOS by the number of grade cells in the MOS. See the example below.

	TOTAL
MOS 12B	493.7 ÷ 5 = 98.74
MOS 12C	487.9 ÷ 5 = 97.58

Add the totals from this process and divide this total by the number of MOSs being merged as depicted in the example below. The product of this process is the average percent of fill for the notional MOS.

AVERAGE PERCENT OF FILL (FILL%)

$$\text{FILL\%} = \left(\sum^{n} \text{FILL}_{MOS}\right) \div n$$

$$= (\text{FILL}_{12B} + \text{FILL}_{12C}) \div 2$$

$$= (98.74 + 97.58) \div 2$$

$$= 98.16 \approx 98\%$$

where

FILL% = Average Percent of Fill

FILL_{MOS} = Percent of Fill for Source MOS

n = Number of Source MOS

Step 3. Determine the current accessions for the combined MOSs. Use FOOTPRINT Report 11 for this procedure. First, determine the number of accessions for the last FY for the merger MOSs and total them. See the example below.

CURRENT ACCESSIONS (ACCESSIONS)	
	FY 90
Accessions 12B	3,266
Accessions 12C	551
ACCESSIONS	3,817

Next, transfer the total of the MOS authorizations baseline from Step 1 of Procedure 1 to your worksheet and multiply this number by the "Average Percent of Fill" as depicted in the example below. The product of this procedure provides the operating strength or number of personnel.

CURRENT NOTIONAL MOS OPERATING STRENGTH (STRENGTH)

STRENGTH = BASELINE x FILL%

= 14,523 x .98

= 14,233

where

STRENGTH = Current Notional MOS Operating Strength

BASELINE = MOS Authorizations Baseline (Procedure 1)

FILL% = Average Percent of Fill

Next, compute the "Notional MOS Accession Rate" by dividing the "Current Accessions" by the "Current Notional MOS Operating Strength" as depicted below.

NOTIONAL MOS ACCESSION RATE (RATE)

RATE = ACCESSIONS/STRENGTH

= 3,817 ÷ 14,233

= 27%

where

RATE = Notional MOS Accession Rate

ACCESSIONS = Current Accessions

STRENGTH = Current Notional MOS Operating Strength

Step 4. Determine the "Notional MOS Accession Constraint." First, multiply the "Notional MOS Authorizations

Constraint" from Procedure 1, Step 4 by the "Average Percent of Fill" as depicted below.

PROJECTED MOS OPERATING STRENGTH (OPSTRENGTH)		
OPSTRENGTH	=	AUTH x FILL%
	=	11,886 x 98%
	=	11,648
where		
AUTH	=	Notional MOS Authorizations Constraint
FILL%	=	Average Percent of Fill

Now multiply the "Projected Operating Strength" by the "Notional MOS Accession Rate" as depicted below.

NOTIONAL MOS ACCESSIONS CONSTRAINT (ACCESS)		
ACCESS	=	OPSTRENGTH x RATE
	=	11,648 x 27%
	=	3,145
where		
ACCESS	=	Notional MOS Accessions Constraint
OPSTRENGTH	=	Projected MOS Operating Strength
RATE	=	Notional MOS Accession Rate

The "Notional MOS Accessions Constraint" is the number of projected accessions needed to keep 11,886 MOS authorizations at 98% of fill.

Step 5. Adjust the "Notional MOS Accessions Constraint" by first subtracting the "Projected MOS Operating Strength" from the "Current Notional MOS Operating Strength" to determine "Excess MOS Operating Strength".

EXCESS MOS OPERATING STRENGTH (EXCESS)		
EXCESS	=	STRENGTH - OPSTRENGTH
	=	14,233 - 11,648
	=	2,485
where		
EXCESS	=	Excess MOS Operating Strength
STRENGTH	=	Current MOS Notional Operating Strength
OPSTRENGTH	=	Project MOS Operating Strength

This number indicates that the current inventory of personnel will need to be further reduced to compensate for the reduction in force. Therefore, accessions need not be as high as projected until the current notional MOS inventory is reduced to a point where the percent of fill is 98%. To ensure an overstrength situation does not occur, accessions must be further reduced. For example, the current MOS fill for "FY 91" is 14,233 and the projected MOS fill for "FY 95" (the date of implementation) is 11,648; then, the accessions must be adjusted down over three years (FY 92, 93, 94) to compensate for this. However, this reduction cannot all be taken from accessions; some must also be taken from retention. When projecting inventory reductions, a good rule-of-thumb is 50% from retention and 50% from accessions.

To determine the adjusted accessions, first divide the "Excess MOS Accessions" by the number of fiscal years remaining until implementation of the notional MOS. See the example below.

YEARLY PERSONNEL REDUCTION (RED)		
RED	=	EXCESS/FY#
	=	2,485/3
	=	828
where		
RED	=	Yearly Personnel Reduction
EXCESS	=	Excess MOS Operating Strength
FY#	=	Number of Fiscal Years until Implementation

Therefore, the current operating strength for notional MOS 12A must be reduced by 828 personnel per year over the next three fiscal years.

To determine the accession reduction, multiply the "Yearly Personnel Reduction" by .50 as described below.

YEARLY ACCESSION REDUCTION (YRRED)

YRRED = RED x 50%

= 828 x .50

= 414

where

YRRED = Yearly Accession Reduction

RED = Yearly Personnel Reduction

Now subtract the MOS Yearly Accession Reduction from the "Constrained Notional MOS Accessions" to determine the adjusted accessions. See the example below.

ADJUSTED ACCESSIONS (ADJACCESS)

ADJACCESS = ACCESS - YRRED

= 3,145 - 414

= 2,730

where

ADJACCESS = Adjusted Accessions

ACCESS = Notional MOS Accessions Constraint

YRRED = Yearly Accession Reduction

Based upon this procedure, the normal constrained accessions for the notional MOS would be 3,145. However, since this action also includes a force reduction, accessions must be further constrained for the three fiscal years prior to implementation. Therefore, constrained accessions are 2,730 for FYs 92, 93, and 94, and then increase to 3,145 in FY 95.

Procedure 5: Training Person Years (Student)

Purpose: Determine notional MOS student training person years constraint

Data Source: FOOTPRINT Report Number 22 for each MOS under consideration for merger

ATRRS data for each MOS

Data from Procedure 4: Accessions

Programs of Instruction for each MOS

Resources: Calculator or spreadsheet

Procedures (5 steps):

Step 1. Determine the average annual student load (LOAD) for each MOS being merged using Active Army training data from ATRRS. See the example below.

AVERAGE ANNUAL STUDENT LOAD PER SOURCE MOS (LOAD)

	CY 90	CY 91	TOTAL	LOAD (2-YEAR AVERAGE)
MOS 12B	2,457	2,128	4,585	2,293
MOS 12C	574	249	823	411

Step 2. Determine the rate of change in source MOS student load due to accession. This is accomplished by computing the ratio of student load modified by accessions to the current student load. See the example below.

RATE OF CHANGE IN LOAD DUE TO ACCESSION (LOAD%Δ)

$$\text{LOAD\%}\Delta = (\text{TLOAD} - \text{ACCESS}\Delta) \div \text{TLOAD}$$
$$= (2{,}704 - 672) \div 2{,}704$$
$$= .75$$

where

$$\text{TLOAD} = \text{LOAD}_{12B} = \text{LOAD}_{12C}$$
$$= 2{,}293 + 411$$
$$= 2{,}704$$

$$\text{ACCESS}\Delta = \text{ACCESSIONS} - \text{ACCESS (Procedure 4)}$$
$$= \text{Current accessions} - \text{Constrained accessions}$$
$$= 3{,}817 - 3{,}145$$
$$= 672$$

Step 3. Determine the projected student load for each source MOS for the FY in which the notional MOS will be implemented. This is accomplished by multiplying each MOS student load by the percentage change in load due to accessions during the implementation year. See example below.

PROJECTED MOS STUDENT LOAD (PLOAD)

$$PLOAD = LOAD \times LOAD\Delta\%$$

$$PLOAD_{12B} = 2{,}293 \times .75 \approx 1{,}723$$

$$PLOAD_{12C} = 411 \times .75 \approx 309$$

where

$PLOAD_X$ = Projected MOS student load (future FY) for MOS_X

$LOAD_X$ = Average annual student load (current) for MOS_X

$LOAD\Delta\%$ = Rate of change in load due to accessions (see Step 2 above) = .75

Step 4. Determine the length of training for each of the MOSs being merged. Use the POIs for each MOS being merged to perform this procedure.

As depicted in Table A-1, the first column of the matrix consists of a list of the training tasks for all MOSs under consideration for merger. The next column identifies the number of training hours spent training the tasks for the first MOS under consideration; the hours are totaled at the bottom of the column. As depicted, additional MOSs will require additional columns and so on, until all MOSs under consideration are annotated in the matrix.

Step 5. Determine training person years (student) for each MOS being merged by multiplying the projected student load by length of training. See example below.

TRAINING PERSON YEARS (STUDENT)

$$TPY = PLOAD \times LENGTH \times CONV$$

$$TPY_{12B} = 1{,}779 \times 220 \times .0005 \approx 189$$

$$TPY_{12C} = 308 \times 272.5 \times .0005 \approx 42$$

where

TPY_X = Training Person Years (Student) for MOS_X

$PLOAD_X$ = Projected MOS Student Load for MOS_X

$LENGTH_X$ = Length of Training (Hours) for MOS_X

$CONV$ = Factor to Convert Hours to Years

= 1/(40 hours per week x 50 weeks per year)

Table A-1

Length of Training Determination

	12B Hrs	12C Hrs
Camouflage	2	2
Rigging	6.5	6.5
Basic Combat Construction	6	6
Demolitions	21	21
Fixed Bridging	18	18
River Crossing Ops.	14	14
Mine Counter Mine Ops.	22	22
Fitness Training	2	2
River Crossing Ops.(S)	0	32.5
Fixed Bridging(S)	0	15.5
Vehicle Operations(S)	0	25
Mine Scattering Systems(S)	7.5	0
Construction(S)	0	4
Wheel & Track Veh Ops.(S)	5	0
Engineer Week	96	96
Reenforcement Training	8	8
End of Course Comprehensive	4	4
Total	220 Hrs	272.5 Hrs

(S) Indicates MOS Specific Training

Step 6. Determine the training person year (student) constraint by summing the training person year values across the source MOSs. See example below.

TRAINING PERSON YEAR (STUDENT) CONSTRAINT (TPYC)		
TYPC	=	$TPY_{12B} + TPY_{12C}$
	=	189 + 42
	=	231

WORKING PAPER 59-201

Procurement and Evaluation Guidance for Acquiring Embedded Training (ET) Components for the Armored Family of Vehicles (AFV)

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

SECTION 1

INTRODUCTION

The Prime Item contracts, which will herald the initiation of engineering design of various vehicles within the Armored Family of Vehicles (AFV), will be preceded by Requests for Proposals (RFPs) to which industrial contractors will respond. The submitted proposals will be focused and structured by the content of the RFPs. Emphases in the RFPs will command attention in the form of process and product descriptions and costing implications. Following award, the developmental programs that result will (or should) also mirror RFP requirements.

Few major acquisition programs to-date have required the design of embedded training (ET) capabilities in conjunction with the engineering design and development of the prime system; the Howitzer Improvement Program (HIP) and to some extent the All Source Analysis System (ASAS) are among those few. ET, while not a new training concept, is new in its systematic, policy-driven application to current Army system acquisitions. As a result, there is a lack of precedent to provide guidance about what should be specified in an RFP to assure that competing contractors propose appropriate analytical and design methodologies for ET.

Purposes of This Document

An earlier study (Roth, Cherry, and Strasel, 1987) investigated the possible roles of ET and Stand-Alone Training Devices (SADs) in individual and collective training for AFV. While task-related design information about the more than thirty (30) possible variations of vehicles making up the "family" was extremely limited, the alternative roles postulated and recommended for ET are factual, if somewhat simplistic (i.e., when vehicle and crew details become known, various clusters of vehicles will be served by training systems which employ different mixes of training media and devices, including ET). However, the preparation of an RFP which appropriately constrains and structures the contractor to perform the necessary analyses and to integrate the results effectively with the engineering design of the prime system, can take advantage of general principles of ET design common to all types of ET applications. In addition, specific ET configurations or characteristics can be prescribed for particular vehicles or vehicle clusters. One purpose of this document is to provide guidance and examples to facilitate integrating ET specifications into a general item RFP.

A second purpose is to provide reference to prescriptive documentation which describes the procedures which the Army has developed for ET design during system acquisition (USARI, 1988; 10 Volumes). AFV RFPs should highlight the availability of these guidelines to encourage potential contractors to propose ET development efforts in accordance with them.

Finally, in addition to providing material and guidance for the preparation of the ET portion of an RFP, this document suggests major technical points, and their characteristics, for judging the appropriateness of proposal responses to the RFP. These evaluation criteria are designed to be integrated with other criteria in developing and applying Proposal Evaluation Plans (PEPs) for AFV vehicles.

Background

ET Definition

ET is defined as training which results from features intentionally included in the design of end item equipment to provide training and practice in using that end item equipment. The trainee trains at his or her duty station. The ET features may be completely embedded within the system configuration, in the form of application software and any necessary ET-unique hardware, or they may result from some form of adjunct or appended components. The features must include presentation of stimuli necessary to support training; they should include performance assessment capability, appropriate feedback for the trainee, adaptivity to trainees' measured performance levels, and record keeping.

ET as a Component of a Complete Training System

Army policy dictates that "an embedded training capability will be thoroughly evaluated and considered as the preferred alternative among other approaches to the incorporation of training subsystems in the development and follow-on Product Improvement Programs of all Army materiel systems."[1] ET seldom, if ever, will constitute the only training approach (training mode) making up the training system for a system. Analytical procedures exist, and are documented in the ET guidelines series referenced earlier (USARI, 1988), which can produce

[1] DA Policy Letter, 3 March 1987, signed by General M. R. Thurman, Vice Chief of Staff and James R. Ambrose, Under Secretary of the Army.

an ET component design which maximizes the training benefit to be derived from an ET configuration in conjunction with other training modes, media types, and training devices.

The implications of ET as a single component of a total training system are important. Since the ET design must complement and fit with the prime item system design, the schedule and responsibilities for the overall system must permit timely ET decisions. The RFP must provide for the mechanism which will configure the total training system, whether the contractor is tasked with total training design, or whether the Army provides the boundary conditions for ET. However they are to be generated, the requirements for the ET component cannot be derived in isolation from the overall system, and early initial estimates, updated as appropriate throughout system development, are essential.

Time-Critical ET Design

Experience has shown that ET design very early in the prime system acquisition cycle is the most essential aspect in the successful integration of embedded training design objectives with those of the prime system. The longer the delay in a firm formulation of ET hardware and software requirements, the lower the probability that ET will be accommodated as part of the overall system. The reason is that effectively integrated ET will require data processing and display capabilities as well as some level of access to the prime system's operating system or executive software, application programs, and database(s). These requirements, in turn, imply the need for system power, hardware space, programming "hooks," and soldier-machine interface accommodation. The further along the prime system engineering design is, the more difficult it becomes to make the system design tradeoffs necessary to integrate ET. With training system developers as an integral part of the total system's design team, ET can be designed as a fully operational subsystem of the prime system.

Scope

AFV Configurations

The Armored Family of Vehicles (AFV) is being developed as a system of armored vehicles characterized by chassis, component, and vetronics commonality; modularity of mission-specific equipment; commonality of battlefield signature; and multiple system capabilities. The AFV concept encompasses at least two generic chassis types and numerous mission modules, as shown in Figure 1-1. Table 1-1 presents definitions of AFV vehicle abbreviations.

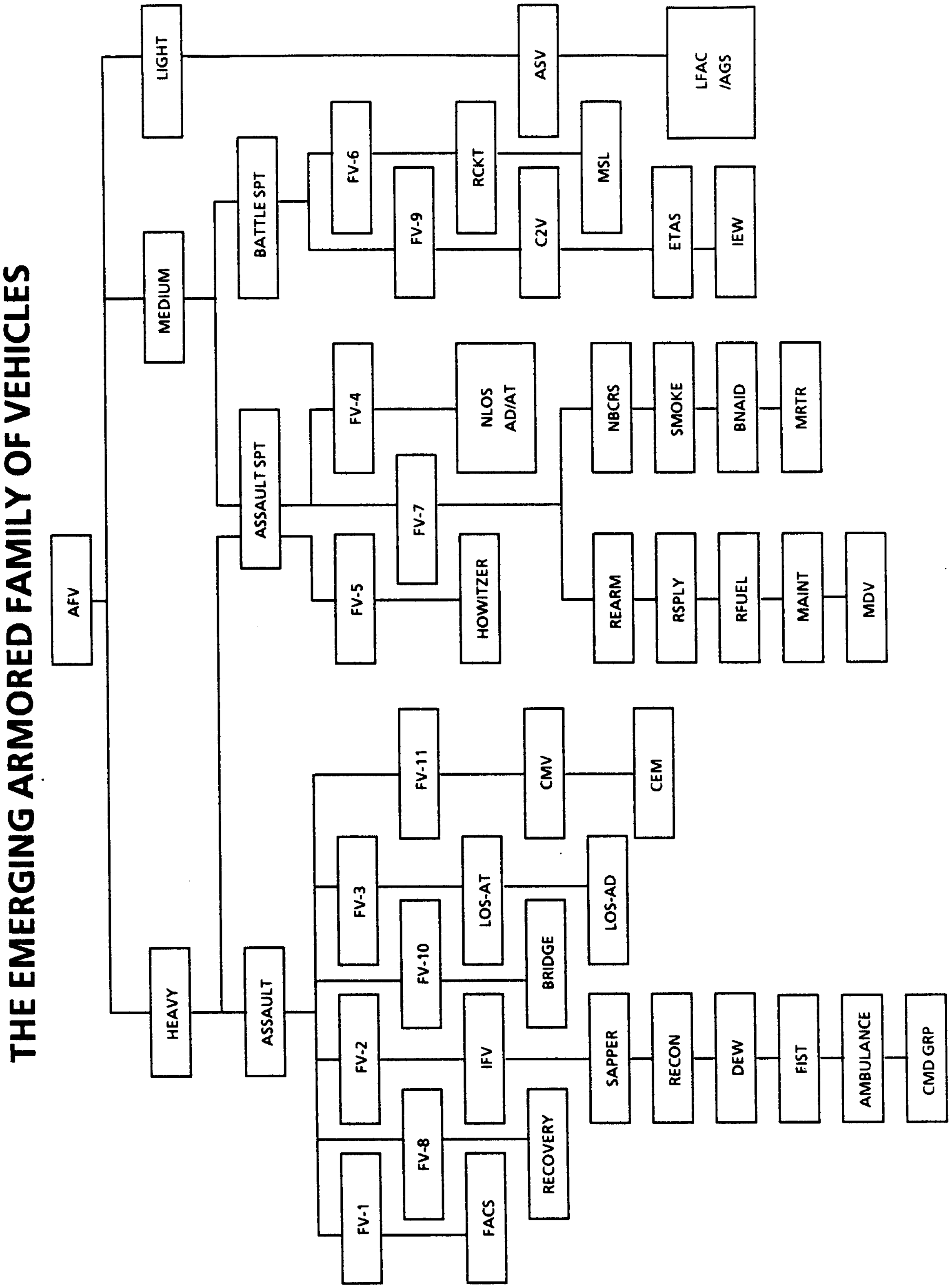

Figure 1-1. The Armored Family of Vehicles "Family Tree"

Table 1-1

EXPLANATION OF ABBREVIATIONS FOR AFV VEHICLES

Heavy Chassis Vehicles

FACS	Future Armored Combat System (a tank)
IFV	AFV Infantry Fighting Vehicle
DEW	AFV Directed Energy Weapon Vehicle
HOWITZER	AFV Howitzer Vehicle
FIST	AFV Fire Support Team Vehicle
SAPPER	AFV Sapper Vehicle
CEM	AFV Combat Earthmover Vehicle
CMV	AFV Combat Mobility Vehicle
BRIDGE	AFV Bridging Vehicle
RECOVERY	AFV Armored Recovery vehicle
AMBULANCE	AFV Armored Field Ambulance
LOS-AD	AFV Line-of-Sight Air Defense Vehicle
LOS-AT	AFV Line-of-Sight Anti-Tank Vehicle
RECON	AFV Battlefield Reconnaissance Vehicle
CMD GRP	AFV Command Group Vehicle

Medium Chassis Vehicles

MRTR	AFV Mortar Vehicle
ETAS	AFV Elevated Target Acquisition System Vehicle
REARM	AFV Armored Rearmament Vehicle
REFUEL	AFV Armored Refueling Vehicle
RESUPPLY	AFV Armored Resupply Vehicle
NBCRS	AFV Nuclear, Biological, and Chemical Warfare Reconnaissance Vehicle
MDV	AFV Mine Dispensing Vehicle
MAINT	AFV Forward Maintenance Vehicle
IEW	AFV Integrated Electronic Warfare Vehicle
SMOKE	AFV Battlefield Smoke Vehicle
BNAID	AFV Armored Battalion Aid Station Vehicle
NLOS-AD/AT	AFV Non-Line-of-Sight Antitank/Air Defense Weapon Vehicle
RCKT	AFV Rocket Vehicle
MSL	AFV Missile Vehicle
C2V	AFV Command and Control Vehicle

Light Chassis Vehicles

LFAC/AGS	Light Future Armored Combat System/Armored Gun System (light forces direct fire assault vehicle)
ASV	AFV Armored Escort/Security Vehicle

Operator and Maintainer Tasks

ET can be made applicable for both operator positions and maintainer positions. "Which position?" and "applicable in what ways?" are questions which, like the "which tasks for ET training?" questions, can only be answered through comprehensive analyses. It will be important, however, for the RFP to clearly indicate that both operator and maintainer tasks must be analyzed in the process of establishing the ET requirements. This document provides guidance for that inclusion.

RFP Preparation

Embedded training design requires analyses of operator and maintainer tasks to identify those for which ET is most cost-effective. Many tasks involving AFV mission-specific equipment have not, as yet, been defined. Detailed definition of these tasks may not occur until well into system development, when the specific configuration and operating characteristics of the soldier-system interface(s) (SSIs) have been designed. Tasks which involve multiple crewmember performance (within a vehicle) and multiple crew performance (in multiple vehicles) are also largely unspecified at this time. The major implication of the lack of system definition this early in a major developmental program is that the RFPs which, among other things, seek to generate responses which will permit selection of a contractor competent to design and develop AFV as a total system or set of systems <u>including ET</u>, cannot specify the tasks for which ET should train. The analyses upon which those training content decisions will be based have yet to be done. They represent part of the product to be procured rather than part of the specification in the RFPs. Therefore, RFPs prepared early in development should specify the nature of the training requirements analyses which will constitute the underpinnings for ET objectives, design, and content. This document outlines those analyses, and provides material to guide the preparation of the ET portions of AFV RFPs.

SECTION 2

ANTICIPATED ET ROLES IN AFV TRAINING SYSTEM

The following discussion of the roles of ET in AFV training is based on the findings from a study to develop training system concepts for AFV (Roth, Cherry, and Strasel, 1987). It should be noted that the conceptual framework for that study was based on assumptions about emerging technologies expected to mature within the early developmental time frame for AFV--from the present to the mid-1990's. The underlying assumptions and methodology used in arriving at these conclusions are presented in the referenced report.

The overall, or "umbrella," training system concept for AFV is presented in matrix form in Figure 2-1. The matrix depicts the application of various candidate means of supporting hands-on training for various training situations and sites. An explanation of the matrix's axes and entries is presented in Table 2-1.

As is apparent from the matrix, ET is a prime candidate for AFV training, and plays a major role at the fielding site and in unit training. ET plays a minor role in institutional training. ET's role in the training system concept developed for AFV is primarily to support transition and New Equipment Training (NET) at the fielding site, and sustainment, upgrade, and cross training in the unit. The "netting," i.e., connection via Local Area Networks (LANs) or Wide-Area Networks (WANs), of individual AFV vehicles' ET components with other ET components, SADs, or command group simulations, will support collective training above the crew level; e.g., for force-on-force or combined arms training. In addition, ET will support fault isolation training for maintainers. The analysis also identifies significant roles for Stand-Alone Training Devices (SADs) in the AFV training concept.

Institutional Training

As envisioned in the umbrella training system concept, ET will provide minor training support, if any, in the institutional setting. Actual equipment training for operator and maintainer hands-on leadership and management training is expected to be the rule in the institution. This concept also identifies the potential to interface a "netted" ET capability with command group simulations, to provide institutional training for commanders and battle staff.

AFV Overall Training System Concept	Hand-On Training Support Approaches												
Training Situations and Sites	System ET	Netted ET/SIMNET	Positional Trainers*† D	CC	SC	DG	IG	SO	MO	BT	Actual Equipment (No ET)**	Team/ Crew Trainers***	Maintenance Trainers
INSTITUTIONAL TRAINING													
Pipeline/Replacement Training													
Individual Operation Skills Aquisition			X	N/A	N/A	X	X	X	X		Limited		
Collective Operation Skills Aquisition											Limited	X	
Maintenance Skills Aquisition											Fam. Only		X
Leadership/Management Training													
Crewmembers	Minor										Limited	X	
Maintainers											Limited		X
Commanders, Battle Staff		SIMNET									Limited	X (Staff)	
FIELDING SITE TRAINING													
New Equipment/Transition Training													
Individual Operation Training	X		X			X	X	X	X		Limited		
Collective Operation Training	X										Limited	X	
Maintainer Training	T/S Only										X		X
UNIT TRAINING													
Sustainment Training													
Individual Operation Training	X		X			X							
Collective Operation Training	X	NET-ET									X	X	
Maintainer Training	T/S Only										X (Job)		
Upgrade/Skill Progression Training													
Individual Operation Training	X										Limited		
Collective Operation Training	X										Limited	X	
Maintainer Training	T/S Only										X (Job)		
Positional Cross-Training													
Individual Operation Training	X										Limited		
Collective Operation Training	X										Limited	X	
Functional Area Training													
Systems Utilization Sustainment		X									X		
Force-Level Training													
Combined Arms Systems Utilization Sustainment		X									X		

* Includes all types of Stand-Alone Training Devices (SADs) used for training equipment operation and utilization at a single crew position. but excluding team or crew trainers (e.g., driver trainers, precision gunnery trainers, equipment operation trainers)

** Includes all use of actual equipment, not utilizing ET capabilities, for training -- including drills, exercises, range firing, etc. -- and comprehends the possible use of engagement simulation devices and equipment such as MILES, WESS, Hoffman device, etc.

*** Includes all SADs which are used to train crews or crew subsets in specific functional or task areas (e.g., COFTs, crew trainers); also includes command group training simulations and SIMNET

† Abbreviations for position titles: D - Driver; CC - Assault Vehicle Commander; SC - Support Vehicle Commander; DG - Direct Fire Weapons Gunner; IG - Indirect Fire Weapons Gunner; SO - Sensor Operator; MO - Mission Equipment Operator; BT - Commanders and Battle Staff

Figure 2-1. AFV "Umbrella" Training System Concept Summary Matrix

Table 2-1

Explanation of Figure 2-1

Matrix Vertical Axis

The vertical axis of the matrix indicates training situations, grouped by training sites (institutional, fielding site, and unit). The training situations included in the vertical axis are composites of those used for the training requirements analyses.

Several training situations are dealt with under each of the three training sites that appear in the vertical axis. Under institutional training, the following situations are included:

1. Pipeline/replacement training, comprehending both individual and collective system operation and utilization skills acquisition;

2. Maintainer skills acquisition; and

3. Leadership/management training for crewmembers, maintainers, and commanders and battle staff.

Under fielding site training, the following situations are included:

1. Individual crewmember system operation and utilization transition training; and

2. Maintainer transition training.

The following training situations are included under unit training:

1. Sustainment training for crewmembers and maintainers;

2. Upgrade and skill progression training for crewmembers and maintainers;

3. Positional cross-training within crews;

4. Functional area sustainment training (collective above crew level, but excluding combined arms); and

5. Force-level combined arms sustainment training.

Table 2-1

Explanation of Figure 2-1 (Continued)

<u>Explanation of Matrix Horizontal Axis</u>

The horizontal axis of the matrix depicts hands-on training support approaches. The hands-on training support approaches that appear in the matrix are the following:

1. "System" ET - Embedded Training employed for purposes of training individuals or crews, provided by the Embedded Training component of one vehicle, not "netted" with other ET components or external data sources.

2. "Netted" ET/Simulation NETwork (SIMNET) - the use of the Embedded Training components of multiple systems in a coordinated, "netted" fashion to provide training at higher than the crew level. The use of the term SIMNET in this title comprehends the potential for interfacing training at multiple sites or with multiple purposes for training above the crew level. For example, members of a battalion Tactical Operations Center (TOC) conducting a Command Post Exercise (CPX) might exchange orders and information over a network with vehicle crews conducting force-on-force simulated training via "netted" ET.

3. Positional trainers - SADs used to train a single crew position at a time. Eight possible varieties of positional trainers, corresponding to eight generic crew positions or Soldier-System Interface (SSI) suites defined in the analysis, are included. They are:

   D - driver trainer

   CC - combat vehicle commander positional trainer (never identified in the analyses, but included for completeness and consistency with the generic SSIs)

   SC - support vehicle commander positional trainer (never identified in the analyses)

Table 2-1

Explanation of Figure 2-1 (Continued)

DG - direct fire weapons gunner positional trainer

IG - indirect fire weapons gunner positional trainer

SO - sensor operator positional trainer (such trainers are likely to be unique to mission modules, but no basis exists for identifying specific variant characteristics at this stage of AFV development)

MO - mission equipment operator positional trainer (such trainers are likely to be unique to mission modules, but no basis exists for identifying specific variant characteristics at this stage of AFV development)

BT - battle staff positional trainer (never identified in the analyses).

4. Actual equipment (no ET) - actual vehicles used for training without use of ET stimulation or simulation capabilities. Such uses include drills, exercises of all sorts, range firing, and other conventional hands-on training uses of vehicles and mission modules. For exercise force-on-force training, this alternative explicitly comprehends the use of engagement simulation devices and support equipment, including Multiple Integrated Laser Engagement Simulation System (MILES) equipment, Weapons Effects Signature Simulators (WESS), etc. This alternative also comprehends the potential use of subcaliber devices for limited area range firing, as well as inert rounds, explosives, and pyrotechnics for handling practice.

5. Team/crew trainers - SADs that train teams or crews or subsets of teams or crews in collective tasks. This alternative also explicitly includes command group training simulation.

6. Maintenance trainers - SADs that train maintenance skills for maintainer Military Occupational Specialities (MOSs).

Table 2-1

Explanation of Figure 2-1 (Continued)

Explanation of Matrix Entries

A number of different entries are used in the matrix cells, each having a different meaning. These meanings are:

1. No entry in a matrix cell indicates that the training support approach indicated is not a candidate for supporting the training situation indicated.

2. An "X" symbol indicates that the hands-on training support approach indicated is a preferred candidate for supporting the training situation indicated. There may be more than one preferred candidate, indicating a mixed support approach is recommended. The "X" symbol is sometimes accompanied by parenthesized words. The symbol (STAFF) indicates the use of command group simulations for commander and battle staff training. The symbol (JOB) indicates that on-job experience serves a training role for maintainers.

3. The symbol "LIMITED" indicates that limited actual equipment training (relative to the baseline of totally conventional, non-device-based actual equipment training) is a candidate for inclusion in the support mix for the indicated training situation.

4. The symbol "MINOR" indicates a potential minor role for the training support approach indicated in supporting the indicated training situation.

5. The symbol "SIMNET" indicates that networked or interactive simulations (potentially including vehicle-level or "netted" ET) are a candidate for supporting the indicated training situation.

6. The symbol "NET-ET" indicates that the use of "netted" ET components between two or more vehicles or mission modules is a candidate for supporting the training situation indicated.

Table 2-1

Explanation of Figure 2-1 (Continued)

7. The symbol "T/S ONLY" indicates that ET is a candidate for maintainer training, but only to support troubleshooting and fault isolation skills training. In this application, ET may or may not be interfaced with external test equipment or built-in test capabilities.

Fielding Site Training

Fielding site training is supported by a mix of ET and device-based training in the AFV umbrella training concept. Individual and crew level transition training and maintenance troubleshooting training are supported by ET.

Unit Training

Unit training is primarily supported by individual and crew-level ET, as well as limited exercise-based actual equipment training. ET is used for maintenance troubleshooting and fault isolation training in the unit. Collective training above the crew level is supported by "netted" ET. Functional area and force-level combined arms training are supported by exercise-based training and command group simulations, possibly interfaced with "netted" ET.

Vehicle Crew Positions

ET will be used to train command, operator, and maintenance crewmembers using the various vehicle configurations. The ET modules that are developed for AFV will accordingly be designed around crew position functions.

The matrix in Figure 2-2 depicts the anticipated crew positions for each AFV configuration. As the figure shows, some positions are common across many vehicles types, for example the Driver, Commander, and Gunner positions, while others are unique to only a few vehicles, such as the Indirect Fire Weapons Gunner and Sensor Operator positions. The information in this matrix can be used later to guide the process of determining ET training requirements commonality for AFV vehicles.

NOTE: The training system concept reflected above for AFV is a very preliminary "forward look" based on tentative data and many assumptions. More current and accurate data, that reflect the preliminary design of AFV vehicles and the tasks required of vehicle crewmembers and maintainers, must be generated and used to refine and update these concepts. If such analyses have not been undertaken before the preparation of AFV prime item procurement documents (for either vehicle chassis classes, mission modules, or both), contractor tasks to conduct such updates are included in later sections of this volume. These tasks should be required in any case to assure that AFV training system analysis and definition are maintained in configurations current with prime item system design.

NOTIONAL CREW POSITIONS/SSIs

VEHICLE/ VARIANT	DRV	ASLT CMDR	NON- ASLT CMDR	DIR WPN GUN	IND WPN GUN	SENS OP	MSN EQP OP	STAFF
Heavy Chassis								
FACS	x	x		x				
IFV	x	x		x			7 (Inf.)	
DEW	x	x		x				
HOWITZER	x		x		x			
FIST	x		x	x			1 (FO)	
SAPPER	x		x	x			5 (Engr.)	
CEM	x		x					
CMV	x		x					
BRIDGE	x		x (also bridge op.)					
RECOVERY	x		x				1 (Crane)	
AMBULANCE	x						2 (Medics)	
LOS-AT	x	x		x				
LOS-AD	x	x		x				
RECON	x	x		x			2 (Scout)	
CMD GRP	x		x					3
Medium Chassis								
MORTAR	x	x			x		1 (Loader)	
ETAS	x		x (Also mission eq. op.)					
REARM	x		x (Also mission eq. op.)					
RESUPPLY	x		x (Also mission eq. op.)					
REFUEL	x		x (Also mission eq. op.)					
NBCRS	x	x		x		x		
MINE DISP.	x		x (Also mission eq. op.)					
MAINTENANCE	x		x (Also mission eq. op.)					
IEW	x		x				5(ETAS,EW)	
SMOKE	x	x			x	x		
BN AID STATION	x						3 (Medical)	
NLOS-AT/AD	x		x (Also gunner)					
ROCKET	x		x		x			
MISSILE	x		x		x			
C2V	x	x		x				5
Light Chassis								
LFACS/AGS	x	x		x				
ASV	x	x		x				

Figure 2-2. Generic Soldier-System Interfaces (SSIs) for AFV Vehicle Variants

SECTION 3

GENERAL CONSIDERATIONS FOR AFV EMBEDDED TRAINING COMPONENTS

Several general considerations should apply when developing or procuring ET components for AFV vehicles, chassis, or mission modules. These are discussed in this section. Suggestions for procurement evaluation criteria related to these considerations, that can be adapted for AFV Proposal Evaluation Plans (PEPs), are presented in a later section of this paper.

Software and Courseware Commonality

The intended commonality of vetronics and crewstation configurations across many or all of the AFV vehicles provides a significant opportunity for developmental and operational savings in providing ET. Such savings can result from exploiting the fact that ET software and courseware from one AFV vehicle variant should, in concept, be directly portable to other variants. Thus, software and courseware to implement (e.g.) driver-training functions could be identical across all the AFV vehicles, or at least across vehicles using the same chassis. Likewise, software and courseware could be adopted (or adapted) from one type of mission-module crewstation (e.g., vehicle commander) on one AFV vehicle to similar crewstations on other AFV vehicles. This potential commonality of software and courseware, if exploited, represents a leverage on the cost of training development (and, perhaps, update) that has seldom been available in other programs. If independent, uncoordinated development of ET components and training content for each AFV vehicle or variant is pursued, this opportunity may be lost.

Conceptually, this savings could be extended even further. If stand-alone training devices (SADs) supporting AFV systems were sufficiently similar in computer and soldier-system interface hardware characteristics to those installed in the actual AFV vehicles, ET software and courseware could be used (directly or slightly modified) for training presented via the SADs (or vice versa). Some augmentation of original software might be necessary; the extent to which this will be true is presently unknown. This approach has the same benefits as ET software and courseware commonality across AFV vehicles--training development and updates could be simplified, and cost reduced, through taking advantage of such commonality. If providing ET-compatible computer equipment on the SADs is not possible, then at least computer-language portability from one environment to the other should be required. This might be accomplished through the mandatory use of Ada as an implementation

programming language, coupled with a requirement that any hardware-dependent software routines be strictly modularized and separable from non-hardware-dependent software components.

Functional Segregation and Integration of Software

If the approach discussed above is adopted in development of ET components for AFV vehicles, then an additional consideration should apply. Since this approach takes advantage of the potential commonality of application of software across AFV vehicles, it should also provide for direct and straightforward integration of software between common and mission-unique AFV elements. For example, if a common driver-training ET component were developed for one or more AFV chassis types, then provisions for integrating the functionality of the (chassis-common) driver-training ET with that of various mission-module-specific ET components should be provided. Given the intended hardware and equipment-function commonality across chassis and mission-module-attaching portions of AFV systems, this approach makes equal sense. If a given mission module can be attached to an (e.g.) AFV heavy chassis, converting that chassis into (e.g.) a tank, then the ET component of that mission module should be able to interface with the chassis ET module in an equally straightforward manner.

Some care is required in implementing this suggestion, however. What is referred to is the capability to have full functionality in the "common" ET components regardless of the mission module that is attached to the common chassis. The "common" ET component should not depend on hardware or software that is to be included in one specific mission module, but not in other mission modules. This means that the "common" ET components should be either designed with full stand-alone functionality, or provisions should be made to ensure that all add-on mission modules provide the additional "common-module" ET-implementing capabilities not included in the "common" components.

There are several possible approaches to fulfilling this need. First, a stand-alone chassis-oriented ET component could be developed and used in all chassis (e.g., a driver trainer with generic software hooks to mission-module ET implementations) without regard to the mission modules to be attached to the common elements of the system, except for the ability to integrate the chassis and mission module ET components. Another approach is to provide a common degree of functionality with respect to the "common" ET components in every mission module (e.g., some portion of the chassis-related ET would be included in the ET component for each mission module, as an adjunct to an incomplete, non-stand-alone ET functionality in the chassis). A third possible alternative is to design the AFV ET components such that a large majority of the functionality of the ET components remains in the common modules (chassis) of AFV vehicles, with only stimulus-presentation and response-sensing hardware present in the mission modules. This requires, however, that the processing hardware, memory, and mass storage requirements for

the worst-case (e.g., most demanding, largest requirement) ET component be included in all AFV chassis ET modules. In some cases, this could represent providing capabilities that are not required for either a mission-module ET implementation or the "common" ET component.

Each approach will almost surely be accompanied by specific design and implementation trade-off requirements. However, one approach should be thoroughly defined and adopted across the life-cycle of AFV, to ensure a consistent and common implementations of ET. The selected approach should be reflected as requirements in acquisition documents, and evaluated as part of the Test and Evaluation (T&E) of the AFV vehicle(s) being procured.

Enable ET to Grow With the AFV Systems

Some technologies projected for ultimate inclusion in AFV vehicles will probably not mature in time to be incorporated in the first generations of AFV vehicles. This implies that Preplanned Product Improvement (P^3I) capability will be an essential element of all AFV designs. As the AFV fleet undergoes P^3I, training will of necessity change also, including the ET components present in the AFV vehicles. This in turn implies that the initial ET developed along with the AFV vehicles should incorporate a similar ability to undergo P^3I.

The specific impacts of a P^3I capability for AFV ET components encompass both expansion and potential add-on capabilities for training presentation. For example, early versions of AFV ET components may not include simulation of the visual environment surrounding the vehicle. The lack of visual simulation capability will preclude presenting some elements of training via the ET component. The maturing of technologies currently in development may provide a degree of miniaturization in high-fidelity computer-driven visual display generators and presentation hardware that is not now possible. Adding such training presentation capability to existing AFV ET components can be relatively straightforward, if the capability to add-on is planned in advance. If the AFV ET components are implemented with a "closed" system architecture, however, such add-ons will probably be difficult or impossible to accomplish without major system redesign.

Likewise, planned-for expansion capabilities for initial ET components may enable the future incorporation of additional training capabilities above those of the original-implementation AFV ET components. One potential for AFV ET is the ability to "network" the ET components of two or more AFV vehicles, to enable collective training above the crew level (e.g., platoon exercises). This capability might not initially be incorporated in first-generation AFV vehicles, for a variety of reasons. A preplanned capability to expand the ET components by adding the ability to communicate between ET components can make the addition of this capability a straightforward proposition. Again, an "open"

system architecture for the implementation of AFV ET underlies the ability to accomplish P3I for the ET components.

A similar situation applies to ET-implementing software supporting AFV ET. While it is practically a foregone conclusion that ET-implementing software will be designed and implemented in accordance with DOD-STD-2167, using structured, modular design and implementation methods, this does not necessarily mean that a software P^3I for AFV ET will be straightforward. In order to simplify adding anticipated capabilities to ET-implementing software, provisions for additional functions (above those to be initially implemented in early-generation ET components) should be made in the design of the initial software. Such provisions could be implemented as functional "stubs," or to-be-defined functional elements, in the initial software. Then, later enhancements to ET functionality could take advantage of the presence of such "stubs." To support this approach, however, at least a general idea of the nature of possible enhancements (and the technology on which they may be based), and their relationships to the initially implemented ET software functions, should be defined. This will enable the inclusion of appropriate "stubs" in the initial ET-implementing software.

P^3I requirements or potentials analysis, and explicit design characteristics and plans to enable P^3I for both ET hardware and implementing software should be required elements of the analyses to define AFV ET requirements and capabilities.

ET Design for Training Modifiability

After initial implementation and fielding, it is inevitable that changes in the training structure, content, and emphasis of ET courseware for AFV vehicles will be required. Such changes and updates in the courseware will continue for the life of the fielded AFV systems. In order to simplify courseware updates, and maximize the Government's flexibility of response in developing updates, some specific features and characteristics should be provided in the design and implementation of AFV ET components.

The most critical characteristic to enable straightforward courseware updates is to prevent courseware elements with any likelihood of being modified from being implemented as <u>line-coded software</u>. Courseware should be implemented, to the maximum possible extent, as data files or easily (externally) modifiable parameters that control the way in which ET-implementing software presents training stimuli, senses response, and evaluates trainee performance. Changes to line-coded ET-implementing software (or system operational software) should not be required in order to update ET courseware.

A parallel argument suggests that a similar design philosophy should be followed with respect to courseware presented by SADs. Such courseware will also require update and modification. To the extent

that AFV ET components and SADs are able to share software and courseware, the possibility exists that a common update capability could be used for both elements of the AFV training system. If implementation hardware and software is common across AFV ET and SADs, then it may be possible to update courseware for the two simultaneously, through the use of a common front-end training authoring capability. While there are likely to be significant differences in the training emphasis of training provided via SADs versus that provided by ET components, there will also probably be courseware that is common between the two. From the standpoint of the cost of training updates (and, thus, AFV life-cycle cost), it is logical to provide for common update capabilities across the training system to the maximum extent possible.

Multiple-Role ET Utilization--Maintainers

The concept of forward maintenance (maintenance conducted in the unit or by directly-supporting maintenance elements) has recently received considerable emphasis. The focus of the "fix-forward" initiative is to enable the maintenance and logistical systems to effect repairs to failed or battle-damaged systems as close to the battle area as possible, to improve maintenance and repair turn-around times and increase the rate of return of "maintenance-down" equipment to operational units. It is logical to project that the "fix-forward" concept will be pursued to at least some extent for AFV vehicles.

If a "fix-forward" concept is selected for one or more AFV vehicles, the provision of technical information to assist maintainers in trouble-shooting and repair of vehicles in forward locations will be an essential consideration. If ET components are provided on the same vehicles, there may exist an opportunity to combine the functionality of an electronic maintenance technical information system and ET to some extent, to provide both job aiding and training for maintainers. This approach may provide some degree of parsimony in implementation relative to separate ET and technical information systems.

For many types of maintenance tasks, particularly procedural repair and service tasks, an ET component may not be the most appropriate means of presenting technical information to maintainers for task support. This statement is primarily based on the argument that using ET as the principal means of maintenance information support is defeated when ET-implementing components of the system are not functional, as will be the case in some equipment malfunctions.

Also, providing procedural technical information to maintainers through an ET component implies in some cases that adjunct display equipment and interface devices for maintainer information presentation will be necessary. It may not be feasible to provide such equipment in forward areas, however. Also, the use of adjunct equipment has logistical and readiness implications that may not be consistent with the

philosophies of rapid redeployability and immediate forward maintenance. For instance, adjunct equipment itself requires transportation, storage, maintenance attention, spare parts, and some training.

Finally, the actual equipment (with or without ET support) is probably not a suitable milieu for initially learning hands-on, procedural tasks. Experience with actual-equipment maintenance training devices has shown (Carroll, et al., 1984)[1] that such devices are considerably less robust and capable in practice (for several types of training) than are purpose-designed simulators or instrumented mockups. Therefore, neither acquisition nor sustainment training of hands-on maintenance tasks appears an appropriate role for ET support.

It is projected that an appropriate role for ET components in maintainer training may be that of a malfunction symptoms simulator, for training troubleshooting and fault isolation skills. In this role, the ET component would present fault indications and test data to maintainers to simulate equipment faults and malfunctions. The maintainers would be supported by this capability in troubleshooting a wide variety of malfunctions, including uncommon but critical problems that may be very subtle or hard to diagnose.

This role probably would not be fulfilled during times of forward deployment. Rather, the ET component could be used for maintenance training in garrison, or during peacetime exercises or mobilization. Other means of technical information presentation to support procedural task performance and forward-deployed use are considered more appropriate; perhaps some type of stand-alone electronic-based maintenance job aiding equipment is more appropriate to this role.

ET Networking

New-generation training devices, such as SIMNET, have established the capability to conduct device-based collective training for crews, crew subsets, and above the crew level. This capability is also a potential in ET for AFV, through the networking, or netting, of ET components. A related potential, to network both ET and SADs of various types and configurations, in flexible networks, should also be considered. Both local-area networking and the possible use of long-haul networks for netted training including ET are potentials for implementing this type of training.

The extent to which ET-based netted training will be feasible or desirable as part of the AFV training system should be a topic explored

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[1]Carroll, R. J., Thocher, L. I., Roth, J. T., and Massey, R. H. (1984). Maintenance training simulators: Their use, cost, and perceived effectiveness. Brooks AFB, TX: Air Force Human Resources Laboratory (AFHRL-TR-84-53).

during early phases of vehicle variant design and development. Contractors or other design agencies involved in AFV training system definition should explicitly study the cost and potential effectiveness of this technique. If netted ET is determined to be a desirable and cost-effective capability, then means for accomplishing netted training should be a specific element of the ET design and implementation process, coordinated with overall system design and development.

SECTION 4

RFP PREPARATION PROCEDURES AND EXAMPLES FOR AFV ET COMPONENT ACQUISITION

Introduction

In this section, guidance is provided for the development of a Request for Proposal (RFP) for the Embedded Training (ET) component of AFV prime item acquisition. The RFP issued must contain as complete and specific information as possible concerning the ET component to assure that potential contractors will be aware of the Government's requirements for ET. These requirements include functional constraints and capabilities of the ET component, potential hardware and software constraints, ET-system integration requirements, and Test and Evaluation needs.

There are two subsections to this section, in addition to these introductory paragraphs. First is a review of the process by which the information for inclusion in the RFP is gathered. The second subsection describes the types of information that should be included in the training portion of an RFP for the acquisition of an AFV prime item system that will include an ET component.

Gathering Information About the RFP

Information for the RFP comes from the Operational & Organizational (O&O) Plan, the System MANPRINT Management Plan (SMMP), and, to a greater extent, the Required Operational Capabilities (ROC) document. These documents describe the functional requirements of the AFV prime systems and cover the expected training requirements for each system. In preparing to draft the RFP, the ROC should be reviewed for ET requirements which should be well defined at this point given the Army's requirements that the ET design evolves concurrently with the AFV prime systems. In preparation for writing the RFP, ROC requirements are converted into specific AFV hardware and software characteristics and specific actions required by the contractor.

ET Inputs to the AFV RFPs

Since the inclusion of an ET component will impact MANPRINT and ILS issues, the development of the RFP should be coordinated with the

System MANPRINT Manager, the ILS Manager, and the TRADOC System Manager. ET component requirements should be listed along with AFV prime system requirements in the MANPRINT and ILS subsections of the following six RFP paragraphs.

1. The Executive Summary summarizes RFP requirements and conveys to industry upper level management the importance that the Army attributes to ET.

2. The Statement of Work (SOW) states the tasks to be performed by the contractor in fulfilling the requirements of the contract, as well as the contract deliverables. ET-related task requirements are stated here.

3. The System Specification states the AFV prime system and ET component physical and functional characteristics, as well as verification criteria.

4. Contract Data Requirements List (CDRL) and Data Item Descriptions (DIDs) states the report and other data or information requirements for specific tasks in the SOW, or data requirements of the system specification.

5. Instructions to Offerors provides helpful hints to proposal writers, as well as specific instructions on the topics to be covered in detail in the technical proposal. Both the task to be performed and contract deliverables are also described in this section.

6. Proposal Evaluation Criteria section provides the technical criteria, and their relative importance, against which technical proposals will be evaluated by the Source Selection Evaluation Board (SSEB). It is here more than anywhere else that the government conveys to industry the importance that it attributes to the consideration and development of the ET component.

The remainder of this subparagraph discusses general ET considerations in each of the above-mentioned RFP sections.

ET in the Executive Summary

This section gives the contractor an overview of the Army's requirements and priorities for the associated AFV procurement. It is important to set the tone for ET in this section. The Army doctrine, that ET must be considered as the first training alternative, should be stated here along with an indication of the relative importance of ET in the source selection process.

ET in the Statement of Work

The Statement of Work (SOW) section of the RFP describes the requirements, stated in terms of minimal acceptable contractor performance, to be addressed in the contractor's proposal. An RFP written for the Development and Production Proveout phase would likely require the contractor to conduct an ET requirements analysis, provide an ET component design description, and call for an ET evaluation in prototype testing. Required technical data, usually in report form, is ordered via the Contract Data Requirements List (CDRL). ET requirements should be described as task statements in paragraph 3, Requirements of the SOW (see MIL-HDBK-245, Preparation of Statement of Work [SOW], for SOW organization and format). TRADOC AMC Pamphlet, MANPRINT Handbook for RFP Development, recommends that MANPRINT be included in the RFP as a single subparagraph of paragraph 3. ET tasks should be stated in the Training subsection of the MANPRINT paragraph. Several recommended ET tasks are presented in the "Sample SOW Inputs for AFV ET Requirements" in the next section of this report.

ET in the System Specification

The system specification is prepared in accordance with MIL-STD-490 (Specification Practices). While the following discussion refers to the current MIL-STD-490A, the reader is cautioned that this document is undergoing revision and the paragraph numbers and titles, as well as content, may change. The following sections are pertinent to the ET component.

1. Paragraph 3.2.1 Performance Characteristics provides the soldier performance requirements that the designed system must achieve. While the ET component is an integral part of the AFV prime system, it has unique characteristics and functional requirements such that it is better addressed as a Critical Item Specification (MIL-STD-490 Type B2).

2. Paragraph 3.6, Manpower, Personnel, and Training, is where the requirement to consider ET as the preferred training alternative should be explicitly stated.

Example ET component characteristics and general functional requirements that should be considered for inclusion in the system specification for particular AFV procurements are presented in the following section of this report.

Contract Data Requirements List (CDRL) and Data Item Descriptions (DIDs)

In addition to stating the report and other data or information requirements for specific tasks in the SOW, or data requirements of the system specification, the CDRL also provides the schedule for, and quantity of, each contract deliverable.

The content and format of data reports are described in terms of Data Item Descriptions (DIDs). Suggested DIDs for use in preparing ET-related data products are described in Army Research Institute (ARI) Research Product, Implementing Embedded Training (ET): Volume 10 of 10: Integrating ET into Acquisition Documentation. These DIDs, or modifications thereof, are recommended for use in AFV procurements involving the contractor-production of ET-related data items.

Instructions to Offerors

This portion of an RFP includes helpful hints and specific instructions on proposal topics that might include reference to useful government documents, in addition to the military standards and specifications normally included, and resources to assist in preparing the offeror's proposal. For example, the Army may find it desirable to make prospective bidders aware of the ET requirements and design analyses procedures presented in the ET guidelines series.

Proposal Evaluation Criteria

The RFP contains a description of the evaluation criteria that will be used to assess proposals to the Government for the development of the AFV prime item. There are seven areas of concern for the evaluation of proposals that include ET component development. These areas are beyond those issues that would be addressed in a proposal for AFV prime item development if ET was not a consideration. Each of these ET-specific criterion areas is addressed below, with guidance supplied to enable the reviewer of a proposal to assess the offeror's proposal as it pertains to ET component development.

The first criterion area centers on the offeror's understanding of the problem. The offeror must demonstrate an understanding of the ways in which the AFV prime system will be used and the training requirements of the system. The offeror should also demonstrate an understanding of the type of users of the ET component and the environment in which the ET will be utilized.

Second, the offeror must understand the requirements for interfacing the ET software and courseware with the AFV prime system software. The offeror must indicate that the training system and the AFV prime system development have to occur in a reciprocal and interacting manner. The offeror should also anticipate foreseeable problems that might occur in the integration of the ET component with the prime system. The offeror should offer approaches for the solution of these problems.

The offeror must also propose suitable method(s) for determining the computing and storage requirements of the ET component vis-a-vis the AFV prime system. The offeror should describe how it will be assured that these requirements will be met without compromising either the ET component or the AFV prime system.

A fifth area of concern that should be addressed in the proposal is the hardware and software interfacing requirements of the ET component and the AFV prime system. The offeror should discuss proposed methods for determining the hardware and software interfacing requirements of the ET component with the AFV prime system and the additional hardware that may be required for the delivery or authoring of the ET courseware.

Another area to be addressed is the communications hardware and software requirements to connect netted ET components of AFV vehicles. The offeror should discuss methods for determining the communications hardware and software requirements of the netted ET components.

The offeror must also present a plan for quality assurance and a test and evaluation program that is consistent with the requirements described in Volume 7 of the ET guidelines. Minimally, this plan should mention:

1. A method for the formative evaluation of courseware to assure that:

    a. All identified ET requirements (ETRs) are incorporated into the courseware,

    b. Instructional sequencing and presentation courseware will satisfy terminal and enabling objectives,

    c. Courseware and performance evaluation parameters are completely consistent, and

    d. The instruction presented by the courseware is effective in conveying appropriate instructional objectives and promoting efficient training (proof of the training concept).

2. A method for the formative evaluation of ET component software such that each software module is tested individually as developed and then in concert with the other software modules (both ET and AFV prime system modules) with which it interfaces;

3. A method for the summative evaluation of courseware such that:

    a. The comprehensiveness and effectiveness of the training may be determined,

    b. The appropriateness and completeness of feedback received by the trainees may be reviewed,

c. The appropriateness of the training adaptivity may be reviewed, and

d. Ease of training modification can be assessed.

4. A method for the summative evaluation of the ET software such that all elements of the software are tested in concert (this may be accomplished with use of a brassboard ET system);

5. A method for the evaluation of all ET related documentation as to clarity, completeness, and ease of use; and

6. A method for testing all aspects of the ET component and the prime system AFV vehicles to determine weaknesses and faults in the system so that pre-fielding remediation can occur.

The offeror should discuss the components that will need to be addressed in the reliability plan that will be required by the contract. This discussion should take into account:

1. The qualitative reliability of the ET component; and

2. The quantitative reliability of the ET component.

Finally, the offeror should provide a review of the proposed maintenance plan. This discussion should cover the following areas:

1. Maintainability factors for the ET component;

2. The appropriate maintenance concept for the ET component;

3. Maintainability prediction techniques that will be used (these must be consistent with MIL-HDBK-472); and

4. The development of utility maintenance test programs for the ET component.

This section provided a general discussion of ET inputs to AFV RFPs. The next section provides more detailed information on the two RFP sections in which the ET requirements are embodied: the SOW and System Specification. It also includes suggested considerations and criteria for addressing ET components in AFV Proposal Evaluation Plans (PEPs).

SECTION 5

SAMPLE ET INPUTS TO SOW, SYSTEM SPECIFICATION, AND EVALUATION CRITERIA FOR AFV

Introduction

This section provides recommended ET inputs for developing AFV SOWs and System Specifications for AFV prime item materiel acquisition efforts. Recommended evaluation criteria, which can be adopted in Proposal Evaluation Plans (PEPs), are also presented in this section. These examples apply general principles of ET design and acquisition, most of which are described in the ET guidelines series, to the development of RFP statements for AFV procurements.

The first subsection provides examples of ET-related statements that might be included in the training sections of RFP Statements of Work for AFV. Examples are given to show how the information discussed may apply to AFV acquisitions.

The second subsection provides examples of the kinds of statements that might occur in the System Specification section of AFV RFPs. This subsection also includes the functional sub-components and characteristics that should be required of any ET component, regardless of the AFV configuration.

The final subsection recommends evaluation criteria which could, and should, be included as ET-related evaluation criteria for AFV proposals' PEPs.

Sample ET Inputs for an RFP Statement of Work

Contractor tasks required for the ET component should be included in the training section of the MANPRINT subparagraph of Paragraph 3: "Requirements" of the SOW.

The SOW contains a list of tasks that the contractor will be required to accomplish. The following paragraphs describe each of the tasks that the contractor should be required to perform in order to produce the ET component for the AFV configurations being procured. Several of these tasks will have to be performed in an iterative fashion as the AFV system proceeds through the concept, development, and production stages. The tasks that may have to be performed iteratively are analytic ones that generate input to the decisions concerning the AFV system design for computer memory, processing, storage, and interfacing. The impact of ET upon AFV must be

considered, assessed, and accommodated in the AFV design from the outset of the acquisition process. Thus, the initial performance of these analytic tasks must be accomplished as early as possible in the development cycle for the prime system. As the design for an AFV system evolves, these early analyses should be updated to reflect the changes in the design.

The following are 17 ET-critical tasks which are recommended for inclusion as contractor task requirements in the Statement of Work section of AFV RFPs.

Task 1: Develop a Test and Evaluation (T&E) Plan. The T&E Plan will be used as input to the Test and Evaluation Master Plan (TEMP) to be developed by the Government. This plan will most likely be contractor executed under Government oversight. As input to the TEMP, this report shall address all pertinent issues, such as those detailed in Volume 7 of the ET guidelines series. The T&E Plan shall accommodate Continuous Evaluation (CE) that includes formative and summative evaluative activities for both ET courseware and software development. This plan shall include a methodology for producing evidence of the training effectiveness of the ET design and courseware. There shall also be a plan to produce evidence for an ET support capability by the associated AFV configuration at all stages of development. Additionally, the T&E Plan shall describe a method for producing concrete evidence of the integration of the ET component and the AFV configuration within the context of a brassboard system. The brassboard ET should be articulated to the AFV buses and interfaces; be driven by the AFV prime item; and be compatible with the soldier-system interfaces of the AFV.

Task 2: Perform a training system analysis to determine the different components of the training system. In this task, the contractor shall determine the roles of the different components of the training system. This task shall include the selection of the components that will comprise the training system. This task may need to be performed iteratively, with the first performance occurring early in the system development cycle. The bidder is referred to Volume 3 of the ET guidelines for guidance on early ET and training system requirements formulation.

Task 3: Perform a task analysis to identify or refine tasks to be trained. The tasks that will appear on the task list will represent all tasks for the AFV prime item that must be taught. This task shall be performed iteratively, with initial performance of the task early in the development cycle. As changes are made in the design of the AFV prime item, the task analysis shall be modified to reflect these changes.

Task 4: Determine ET requirements (ETRs). The contractor shall apply procedures--similar to those outlined in Volume 4 of the ET guidelines--to identify the tasks to be trained via ET from those tasks identified for training in Task 3. This task shall be performed iteratively, as the design process for the AFV prime item proceeds. An ETR report shall be produced for each iteration of this task.

Task 5: Develop a courseware concept for ET. The contractor shall develop a concept of the type of training which will utilize ET. This concept shall contain enough detail on the types of tasks to be trained and how they will be trained to inform the software development and hardware selection processes as to the expected software, hardware, and processing needs of ET. The courseware concept shall indicate to the software developers the types of "hooks" that must exist so that the training may be integrated with AFV prime system software, as well as providing at a minimum rough estimates for memory, storage, and processing requirements. For example, if it is expected that simulation will be called for, or if ET will stimulate the AFV prime item's database software for training purposes, then the courseware concept shall include this information.

Task 6: Develop a critical item specification for the ET component. The critical item specification shall reflect the information presented in the courseware concept developed in Task 5. (It is possible that this task will be performed previous to the issuance of the RFP.) If the specification has not been developed prior to the RFP, then the contractor shall be required to produce it, in accordance with (IAW) MIL-STD-490. The offeror is referred to Volume 5 of the ET guidelines for procedures and guidance on designing an ET Component concept.

Task 7: Develop an AFV prime item development specification that includes both the AFV prime item and the ET component. The contractor shall develop an AFV Prime Item Development Specification for each prime item and its ET component IAW MIL-STD 490. (This task may have been performed prior to the issuance of the RFP.)

Task 8: Design the ET component. This task requires, first, that the contractor determine training objectives from the list of tasks identified as ETRs in Task 4. After the training objectives have been determined, the contractor shall apply procedures similar to those presented in Volume 5 of the ET guidelines series to develop the design for the ET component. This task shall be performed iteratively, beginning in the system concept development phase and extending into the production and deployment phase, in order to modify the ET component design as the design for the overall AFV prime item is modified.

Task 9: Determine the methods that will be used for the implementation of simulation and stimulation of the AFV prime item software by the ET software. In this task, the support requirements that were delineated by the courseware concept produced in Task 5 shall be expanded upon. At all points during the development phase of the system acquisition process, the prime item and ET software designs shall articulate in order to produce an integrated system. Thus, the determination of the methods to be used to stimulate and simulate the AFV prime item software by the ET software shall be a continuing process. The information for this task shall come from (at a minimum) the ET component design produced in Task 8 and data supplied by the software engineers designing the AFV prime item.

Task 10: Determine student parameters to be recorded and the evaluations that will be made. The determination of student parameters to be sensed by the ET system shall be based on the component design and training objectives.

Task 11: Determine the methods by which student performance recording during interaction with the ET component will be implemented. Decisions concerning how student performance will be recorded by the software, where the performance information will reside (temporary or permanent storage), and how this information will be utilized in the production of feedback, records, and reports will be dependent on constraints on the total system. Initial determination shall be done as early in the development phase as possible and shall evolve as the AFV prime item does. Thus, this task shall be performed iteratively.

Task 12: Develop a software specification for the AFV prime item, including the software associated with the ET component. The software specification shall be developed IAW MIL-STD-490 and shall contain the functional components of the both the AFV prime item software and the ET software and courseware.

Task 13: Develop a hardware specification for the AFV prime item to include hardware aspects associated with the ET component. The hardware specification shall be developed IAW MIL-STD-490. If the ET component requires hardware in addition to that needed by the AFV prime item, the functions supplied by the ET specific items shall be included in this specification.

Task 14: Generate ET and support documentation. The ET that is generated shall have the functional characteristics and sub-components as specified by the specifications developed in Tasks 6, 7, 12, and 13. The contractor shall also develop documentation to support the use of ET.

Task 15: Test and Evaluate ET. The contractor will may be required to conduct tests and evaluations of the ET component, as determined by the Government . Test and Evaluation (T&E) for the ET component shall be an on-going process, from the time of system conception to the final Quality Assurance tests performed on the end items to be delivered. There are several types of evaluation that must be performed during the acquisition process for a system that will include ET:

1. The AFV prime item design shall be evaluated for its capability to support the proposed ET. This evaluation shall occur during the system concept and development stages.

2. The ET software shall be evaluated for its logic, performance, and efficiency as it is being implemented and upon completion.

3. The courseware shall be tested, first, as a proof of the training methods selected (pedagogical evaluation) and

then, after implementation, for its training capability to demonstrate that the training delivered meets the training objectives in terms of soldier performance requirements. The courseware shall also undergo constant quality assurance checks as it is being developed.

4. The reliability and maintainability of the ET component shall be assessed. The evaluation of ET shall occur at several points during the acquisition cycle, and will require many different methodologies to be used for T&E, including breadboard and brassboard development and testing (see Volume 7 of the ET guidelines series for a discussion of the types of evaluations, the timing of evaluations, and examples of evaluation methodologies).

Task 16: Establish an ET Reliability Program. The contractor shall establish a Reliability Program for the ET IAW MIL-STD-785. This reliability program may be subsumed under the reliability program for the AFV prime item or it may be separate. In either case, the program shall include the following:

1. The features of the ET component that will result in reliable and stable performance in the planned operational environment;

2. A review of the ET component system requirements so as establish an accurate description of all parameters which may affect system performance;

3. A description of the operational environment;

4. An estimation of inherent reliability as operational reliability;

5. An analysis of the proposed design to obtain component reliability allocation and allowable failure rates of ET-specific components;

6. The optimum use of redundancy through the system; and

7. An evaluation of ET component reliability to determine if ET performs in accordance with the program and the pertinent specifications.

Task 17: Establish an ET Maintenance Program. The maintenance program shall consist of a maintenance plan and concrete evidence of the maintainability of the ET component. The maintenance plan shall address the following topics:

1. The maintenance concept for the ET component;

2. Prevention of negative impact on AFV prime item RAM;

3. The quantitative maintainability factors associated with the ET component; and

4. The maintainability prediction technique used by the contractor.

In order to demonstrate the maintainability of the ET component, the contractor shall conduct a test of the ET component's fault isolation capabilities and maintainability. To present evidence of the system's maintainability, the total time required to perform each day's preventative maintenance tasks shall be treated as one task.

The tasks described in this section are designed to ensure that ET component requirements are addressed early in the system development process, and that the ET component is developed concurrently with the prime system. It is only through early and iterative ET requirements identification and concurrent interactive ET and prime item system development that an effective ET-prime system integration can be achieved.

Sample Inputs For the ET Component in the RFP System Specification

The paragraphs in this subsection provide examples of ET-related requirements that might be included in the System Specification section of an AFV prime item RFP. The recommendations and examples are presented in the form of a model System Specification in order to illustrate their application in system specification format.

Model RFP System Specification For ET Acquisition

Title (Title of AFV prime item) EMBEDDED TRAINING COMPONENT

1.0 Scope

This (Volume, Section, Paragraph, or Annex [choose the appropriate item]) Statement of Work (SOW) addresses the functional constraints and capabilities of the (name of prime system) Embedded Training (ET) component, the potential hardware and software constraints, ET-prime system integration requirements, and Test and Evaluation needs.

1.1 Introduction/Background. Provide a general description of the relevant elements or functions of the prime system and the ET component.

1.1.1 Functional Description of Prime System. Refer to the System Specification for a description of the functional characteristics of the prime item system that are relevant to ET functions or integration requirements. Describe the relationship between AFV prime item system elements or functions and related ET component functions.

1.1.2 Description of the Training Audience. Refer to the Target Audience Description (TAD) from the applicable System MANPRINT Management Plan (SMMP) for a description of the composition and aptitudes of the intended training audience.

1.1.2.1 Training Managers. Describe the instructors' or training managers' experience with similar training and prime systems.

Example: "Training managers will use the ET component to perform such tasks inserting simulation scenarios, setting performance parameters to recorded, and evaluating student performance. The training managers in charge of the (name of prime system) ET component will be experienced instructors with at least three years experience in instructing trainees on training simulators for the (name of prime system), but will have had no experience managing training on an ET component."

1.1.2.2 Training Developers. Describe the training developers' training development background.

Example: "The training developers will all be experienced in developing courseware for simulators, other training devices, and conventional training media and methods. However, they will not be experienced in the development of ET. They will require a training development capability compatible with the ET component which provides the capability to create or modify courseware.

2.0 Applicable Documents

2.1 Military Specifications

2.2 Military Standards

MIL-STD-490

MIL-STD-1379

MIL-STD-1472

2.3 Other Publications

Organizational and Operational (O&O) Plan;

Required Operational Capability (ROC); and

ET Guidelines: Implementing Embedded Training (ET):

Volume 1 of 10: Overview

Volume 2 of 10: ET as a System Alternative

Volume 3 of 10: The Role of ET in the Training System Concept

Volume 4 of 10: Identifying ET Requirements

Volume 5 of 10: Designing the ET Component

Volume 6 of 10: Integrating ET with the Prime System

Volume 7 of 10: ET Test and Evaluation

Volume 8 of 10: Incorporating ET into Unit Training

Volume 9 of 10: Logistics Implications

Volume 10 of 10: Integrating ET into Acquisition Documentation

Critical Item or AFV Prime Item Development Specifications that pertain to the ET component and the prime system (if available).

3.0 Requirements

3.1 General Characteristics. State the general characteristics of the ET component.

Example: "The ET component shall be fully compatible with the (name of prime system) and shall have the following characteristics (note the following are examples):

1. All ET-specific software shall operate in concert with (name of prime system) software.

2. All ET-specific hardware shall be compatible with the (name of prime system) hardware and software interfaces.

3. The ET component shall be as fully integrated with the prime system as possible. The training shall utilize the inherent AFV system hardware and software to the maximum extent possible. Transition from the operational mode to the ET mode or vice versa shall require less than (insert time limit) to accomplish. However, this requirement for integration shall not preclude the possibility of strap-on or adjunct ET as long as the training configuration is such that the transition time is acceptable for the system, and that the ET component utilizes as much inherent Soldier-System Interface (SSI) and other system hardware as possible, with the addition of any required training-specific adjunct interface equipment.

4. The ET component shall not compromise the security of the system and its data. Thus, all users shall be restricted in their access to prime system data during their use of the ET component. The data accessed shall be determined by the

nature and classification of the information, the type of task for which the ET component is being used, and the clearance and category of the user (e.g., trainee, training manager, training developer, or ET maintainer) accessing the ET.

5. The ET component shall have minimal impact on the prime system's Reliability, Availability, and Maintainability (RAM). This requirement will impact the maintenance plan that the contractor will develop in that the plan shall include a means for determining ET impact on the prime system RAM so that remedial action may be taken once RAM parameters fall below specific, defined RAM index criteria.

6. The ET component shall be constrained by the characteristics and employment of the prime system. For example, courseware shall embody procedures strictly analogous to operational procedures for system utilization in accordance with applicable doctrine and system operational documentation.

7. The ET component shall not endanger personnel, equipment, or (name of prime system) data; it shall not permit unsafe operation while in training mode. The ET component shall be designed to prevent the possibility of accidents of this nature. The ET component shall be designed so that the user is aware at all times of the mode of operation (i.e., ET vs. operational) in which the system is running. The ET component shall include fail safe mechanisms to prevent a weapon from being fired during any training session)."

3.1.1 ET Component Functional Requirements. State the functional requirements of the ET sub-components.

3.1.2 ET Sub-Component Functional Requirements

1. Storage Sub-Component. State the storage requirements for the ET component.

   Example: "The storage sub-component shall provide enough capacity for the passive storage of:

   a. Training courseware;

   b. Performance and evaluation data records for trainees;

   c. Help facility to provide information about use of the ET component;

   d. User identification information;

   e. Interface software for peripherals as needed;

   f. ET training management software;

g. ET soldier-system interface software;

h. Training development software;

i. ET utility software; and

j. Communications software."

2. Memory Sub-Component. State the ET computer memory sub-component requirements.

Example: "The ET component computer memory shall have the memory capacity (which may utilize some or all memory used for normal system operations) to run the ET software and the appropriate prime system application software as part of the training session."

3. Processing Sub-Component. State the ET component computer processing requirements.

Example: "The ET processing sub-component shall have adequate speed to enable the trainee to practice tasks in real time."

4. Hardware Interface Sub-Component. State any hardware interface requirements.

Example: "A hardware interface sub-component shall be included, if it is determined that the ET component will utilize additional hardware beyond that which is within the operation-configured prime system."

5. Software Interface Sub-Component. State the ET software interface requirements.

Example: "The software interface sub-component shall provide for interfacing:

a. The ET management software to the prime system software;

b. The ET management software with courseware and records files;

c. The ET management software with courseware development software (if applicable);

d. The ET management software with communications software (if applicable);

e. Courseware with operating system applications files via the ET management software; and

f. Peripherals with the ET management software."

6. Soldier-System Interface (SSI) Sub-Component. State the ET component SSI requirements.

Example: "The SSI sub-component shall provide the capability to:

a. Use the prime system's interface with the soldiers (crewmembers);

b. Respond appropriately to the trainee, the environment, the prime system, and the other ET sub-components;

c. Indicate unambiguously that the training mode is engaged and operating; and

d. Be in compliance with MIL-STD-1472."

7. Display or Output Sub-Component. State the ET component display or output requirements, if they are different than those of the prime system.

Example: "The ET component shall use the (name of prime system) displays for training purposes."

8. Input Sub-Component. State the ET component input requirements, if they are different than those of the prime system.

Example: "The ET component shall use the (name of prime system) input devices for training purposes."

9. ET Management Sub-Component. State the ET management software requirements.

Example: "The ET management software sub-component shall provide for:

a. Security and protection of classified material;

b. Rapid switching between training and operational mode;

c. Protection of training data;

d. Protection of the prime system, personnel, and against accidental misuse;

e. Stimulation of the prime system software as necessary by the courseware;

f. The support of all other ET sub-components; and

g. The training being driven by the prime system operating system or executive."

10. Training Sub-Component. State the ET training sub-component requirements.

Example: "The training sub-component shall have the following characteristics. It shall:

a. Present training for the identified audience;

b. Support the identified training requirements;

c. Present training for degraded modes of operation;

d. Present training in operator-level maintenance;

e. Promote a high level of system-learner interaction;

f. Manifest appropriate and accepted training methods;

g. Support simulation and stimulation of the prime system's applications software;

h. Record student performance in temporary and permanent files, the parameters for which are supplied with default values and are also modifiable by the training manager;

i. Produce appropriate feedback;

j. Utilize the selected input and output devices;

k. Utilize training developed by the training development sub-component;

l. Support collective training, if required;

m. Support the communications sub-component;

n. Support the production of student performance reports;

o. Be adaptive to student performance; and

p. Support courseware that is linear or with branching at points where particular responses can be identified to require differential treatment."

11. Training Development Sub-Component. State the ET training development sub-component requirements.

Example: "A training development sub-component (or courseware authoring system or language) shall be included with the ET component. This sub-component shall:

a. Support the development of new training or modification of existing courseware (post-fielding);

b. Support the devices selected for training output and trainee input;

c. Support the development of training that includes the stimulation and simulation of the prime system's applications software;

d. Support the selection of student responses to be recorded and evaluated;

e. Support the specification of student performance reports;

f. Support the communications sub-component;

g. Support the production of ET utilization reports;

h. Support the development of training that is linear or with branching at points where particular responses can be identified to require differential treatment; and

i. Allow for courseware development and production at any site selected by the government for this purpose."

12. <u>Data Management Sub-Component</u>. State the ET data management requirements.

Example: "The ET component shall have the capability to produce reports on student performance and on training utilization. Data for these reports shall be stored in various databases. These data shall be retrievable as screen displays and reports. Other data shall also be stored for internal use by the ET component. The data management sub-component will accomplish these functions. This sub-component shall support procedures for establishing databases; generating reports; and storing, retrieving, modifying, and using records and databases of the following categories of data, at a minimum:

a. Student performance and evaluation records;

b. User identification records; and

c. ET utilization records."

13. <u>Communications Sub-Component</u>. State the ET communication requirements.

Example: "The communications sub-component shall allow for data transfer by Local Area Network (LAN) or other electronic mode(s) as determined necessary to support the following:

a. Collective training;

b. Courseware transfer from the locus of development to the locus of utilization; and

c. Student and training records transfer from the locus of training utilization to other sites where such information will be processed or otherwise used."

14. Utility Sub-Component. State the ET utility programs requirements.

Example: "The ET component shall support several other functions that can be included in a utility sub-component. The utility sub-component should include:

a. A maintenance test program;

b. The capability to allow for the accessing and modification of user identification information;

c. The capability to allow access to the source code for all ET programs;

d. The capability to decompile and recompile all ET source code, and

e. A self-initiating fault-detection test on ET start-up with capability to alert the ET user when the ET component is not functioning properly."

3.2 Training Requirements. State the general training requirements concept for the ET component.

Example: "The ET component shall provide acquisition and/or sustainment training for individual operator trainees for the (name of prime system) (name of operator positions). Acquisition training will be conducted at (name of Fort), while sustainment training will be conducted primarily in the unit."

3.2.1 New Equipment Training (NET) Requirements. State whether or not the ET component will support the New Equipment Training Plan (NETP) for the system.

Example: "The ET component shall provide support for the NETP for the (name of prime system)."

3.2.2 Types of Tasks to be Trained. Describe the types of tasks for which ET component will be required to provide training.

Example: "The ET component shall have the capability to provide training on the following (name of prime system) tasks: [EXAMPLES ONLY] system initialization, target acquisition (with radar and optical sight), Identify Friend or Foe (IFF) assessment, missile launch, damage assessment, and system checkout functions."

4.0 Support Documentation. List and describe support documentation the contractor is to produce.

Example: "The contractor shall supply documentation to support the use of the ET component. This documentation is required to provide instruction on the utilization of ET by the trainees, training managers, training developers, and ET maintainers. The following types of documentation shall be provided by the contractor:

1. Student handbook: the student handbook shall include instructions on how to initiate a training session, a listing of all executable lessons and associated training objectives, diagrams indicating the flow of instruction, and a discussion on the relationships between the ET and other components of the training system;

2. Student supplementary materials: if needed, materials required by the student to supplement ET shall be provided;

3. Instructor and training manager handbook: the instructor and training manager handbook shall include a listing of the training objectives of ET, procedures for integrating ET with other training media and methods, procedures for monitoring student performance, procedures for setting performance assessment parameters, and procedures for records maintenance and report production;

4. Courseware authoring manual: the courseware authoring manual shall contain (at a minimum) a list of functions that may be performed using the authoring system, a list of the commands for performing the functions, and examples for developing courseware;

5. Maintenance and repair manuals: the maintenance and repair manuals shall contain all the information needed for updating the ET software, inserting modified courseware, decompiling and recompiling files, changing user status, performing daily ET maintenance tasks, and troubleshooting and repairing the system; and

6. Hardcopy of the nonproprietary uncompiled code for ET software. Also, both electronic and hard copies of all ET courseware shall be provided."

ET Component Evaluation in the Proposal Evaluation Plan (PEP)

This subsection provides an example of the types of ET-specific evaluation criteria that should be considered for inclusion in the Proposal Evaluation Plans (PEPs) of all AFV acquisitions involving ET components.

Generic Evaluation Criteria

The following are examples of generic ET-related statements which might be included in a PEP:

1. Understanding the problem. How well does the offeror demonstrate an understanding of the ways in which the AFV prime system will be used, and the related training requirements for the system? Does he demonstrate an understanding of the type of users of the ET component, and the environment in which the ET will be utilized?

2. Understanding of ET-prime system software integration issues. Does the offeror demonstrate an understanding of the requirements for interfacing the ET software and courseware with the AFV prime system software? Does he foresee problems that might occur in the integration of the ET component with the AFV prime system, and offer sound approaches for the solution of these problems?

3. Assessment of ET impact on prime system computing and storage requirements. Does the offeror propose suitable method(s) for determining the computing and storage requirements of the ET component vis-a-vis the prime system, and describe how he intends to assure that these requirements will be met without compromising the ET component or the prime system? Are methods of trade-off determination relevant to ET capabilities and functions specified, and contingency plans provided to ensure full training capability if ET functions cannot be integrated into the prime system?

4. Assessment of ET component hardware and software interface requirements. Does the offeror describe a sound methodology for determining the hardware and software interfacing requirements of the ET component with the prime system and the additional hardware that may be required for the delivery or authoring of the ET courseware?

5. Quality assurance and test and evaluation plans. Does the offeror present a sound and comprehensive plan for an ET-oriented quality assurance and test and evaluation program? Minimally, this plan should include:

   a. A method for the formative evaluation of courseware to assure that:

      1) all identified ETRs are incorporated into the courseware,

      2) instructional sequencing and presentation courseware will satisfy terminal and enabling objectives,

3) courseware and performance evaluation parameters are completely consistent, and

4) the instruction presented by the courseware is palatable and effective in conveying appropriate instructional objectives and promoting efficient training (proof of the training concept).

b. A method for the formative evaluation of ET component software such that each software module is tested individually as developed and then in concert with the other software modules (both ET and prime system modules) with which it interfaces;

c. A method for the summative evaluation of courseware such that:

1) the comprehensiveness and effectiveness of the training may be determined,

2) the appropriateness and completeness of feedback received by the trainees may be reviewed,

3) the appropriateness of training adaptivity may be reviewed, and

4) ease of training modification can be assessed.

d. A method for the summative evaluation of the ET software such that all elements of the software are tested in concert (this may be accomplished with use of a brassboard ET system);

e. A method for the evaluation of all ET related documentation as to clarity, completeness, and ease of use; and

f. A method for testing all aspects of the ET component and the prime system to determine weaknesses and faults in the system so that pre-fielding remediation can occur.

6. Inclusion of ET in reliability plan. How well does the offeror discuss how the ET component will be addressed in the reliability plan required by the prime system contract? This discussion should take into account the qualitative reliability of the ET component.

7. ET component maintenance plan. How well does the offeror's maintenance plan adequately address the following areas:

a. Maintainability factors for the ET component;

b. The appropriate maintenance concept for the ET component;

c. Maintainability prediction techniques he will use (these must be consistent with MIL-HDBK-472); and

d. The development of utility maintenance test program for the ET component.

8. Proposed project personnel. Does the offeror propose personnel who are experienced in all areas of ET requirements analysis and design.

AFV-Issues--Related Items

In addition to the generic evaluation criteria and questions listed above, there are additional criteria and questions related to the general AFV ET considerations in Section 3 of this document that should be considered for inclusion in AFV PEPs. These are:

1. Software and Courseware Commonality. Is common ET-implementing hardware, that takes advantage of previous design efforts, proposed for inclusion in the ET component? Are common ET-implementing software routines, that take advantage of previous design, proposed for utilization? Has a detailed survey of available ET-implementing hardware and software on previous AFV variants been made by the offeror (or the Government), and are the results of such a survey cited in estimating the common utilization of existing hardware and software?

2. Functional Segregation and Integration of Software. Is common utilization of software between AFV ET components and other elements of the total training system (e.g., Stand-alone Training Devices, or SADs) proposed? Are initiatives specified to take advantage of previous ET and SAD design and implementation efforts? If SADs (or other elements of the training system) are being procured separately from the ET component(s), does the offeror propose data-sharing and associate contractor agreements to enable the cooperative utilization of developmental products and data between the prime item (and ET) and SAD (or other-element) development efforts?

   Are proposed elements of the ET component completely compatible and interoperable from both hardware and software standpoints? If only a mission module is being developed, are the specific characteristics of the ET component contained in the chassis (both hardware and software) considered as mandatory-utilization design constraints? If sufficient ET capability to provide stand-alone chassis-crewmember-only training is not available in the chassis portion of the ET component, does the mission module ET component proposed provide the capability to

augment the chassis ET component such that all planned ET-based training can be provided for chassis-crewmembers?

3. Enable ET to Grow With the AFV Systems. Are P^3I considerations provided for in the proposed design characteristics of the ET component? Is there an explicit plan to provide for future inclusion of training (e.g., stimulus-presentation, response-sensing, or performance measurement) capabilities that are not planned to be incorporated in initial ET capabilities? Is sufficient growth capability and integration potential proposed for the design of initial ET-implementing hardware and software to provide for P^3I of the ET component? Are the implications of presently immature technology for potential future P^3I of ET evaluated and discussed? Is an adequate plan provided to incorporate further consideration of the training capabilities potentially afforded by new technology developments into the design of the ET component to support P^3I? If not an initial requirement, is the capability to network the ET components of multiple vehicles (to enable collective training above the crew level) provided for as part of the P^3I plan for ET?

4. ET Design for Training Modifiability. Does the proposed design of ET-implementing software and courseware, as well as software and courseware for proposed training devices, incorporate features that will enable training updates and modifications to be carried out in a straightforward manner? Is the implementation of courseware with any likelihood of modification specified to be in the form of data files, rather than as line-coded software? Is there consideration of developing ET and SADs in such a fashion that the two elements of the training system can utilize common courseware and software? Are specific analyses proposed to investigate this potential?

5. Multiple-Role ET Utilization--Maintainers. Is appropriate consideration given to the potential utilization of AFV ET components for maintenance training, as well as operator or crew training? Are appropriate roles for maintenance-oriented ET-implemented training defined? Are alternative maintenance training and job-performance information sources specified for roles where ET is considered inappropriate or potentially ineffective to support maintenance training?

6. ET Networking. Are appropriate analyses proposed to identify and define the extent to which networking of ET components and/or SADs should be an integral element of AFV training system design? Are there appropriate cost and effectiveness tradeoff methods and criteria proposed to enable a rational exploration of the value and contribution

to life cycle cost savings of the networked ET and device approach to training?

APPENDIX A

REFERENCES

Barber, J. L., Jones, R. E., Jr., Ching, H. L. F., & Miles, J. L. Jr. (1987). MANPRINT handbook for RFP development (AMC Pamphlet 602-1). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Department of the Army (1987). Force development: Materiel objectives and requirements (AR 71-9). Washington, DC: Department of the Army.

Department of the Army (1987). Manpower and personnel integration (MANPRINT) in the materiel acquisition process (AR 602-2). Washington, DC: Headquarters, Department of the Army.

Department of Army (1986). Research, development, and acquisition: Systems acquisition policy and procedure (AR 70-1). Washington, DC: Headquarters, Department of the Army.

Department of the Army (1986). Research, development, and acquisition: Test and evaluation (AR 70-10). Washington, DC: Department of the Army.

Department of the Army (1983). Logistics: Integrated logistic support plan (AR 700-127). Washington, DC: Department of the Army.

Department of the Army (1975). Life cycle systems management model for Army systems (Pam No. 11-25). Washington, DC: Headquarters, Department of the Army.

Department of Defense (1987). Military standard: Human engineering design criteria for military systems, equipment and facilities (MIL-STD-1472C). Washington, DC: Department of Defense.

Department of Defense (1986). Military standard: Preparation of data item descriptions (DIDs) (DOD-STD-963A). Washington, DC: Department of Defense.

Department of Defense (1985). Military standard: Specification practices (MIL-STD-490A). Washington, DC: Department of Defense.

Department of Defense (1983). Military handbook: Preparation of statement of work (SOW) (MIL-HDBK-245B). Washington, DC: Department of Defense.

Department of Defense (1981). Military specification: Requirements for training system development [MIL-T-29053B(TD)]. Washington, DC: Department of Defense.

Department of Defense (1987). Military standard: Contract training programs (MIL-STD-1379C). Washington, DC: Department of Defense.

Department of Defense (1980). Military standard: Reliability program for systems and equipment development and production (MIL-STD-785B). Washington, DC: Department of Defense.

Department of Defense (1966). Military standardization handbook: Maintainability prediction (MIL-HDBK-472). Washington, DC: Department of Defense.

Roth, J. T., Cherry, W. P., and Strasel, H. C. (1987). Training systems concepts for the armored family of vehicles with consideration of the roles of embedded training and stand-alone training devices. Butler, PA: Applied Science Associates, Inc., August 1987.

U.S. Army, HQ, Training and Doctrine Command (1982). Schools: Individual and collective training plan for developing systems: Policy and procedures. TRADOC Regulation 351-9.

U.S. Army, HQ, Training & Doctrine Command (1987). Materiel acquisition handbook, AMC/TRADOC Pamphlet 70-2.

U.S. Army, HQ, Training and Doctrine Command. Systems training development, TRADOC Regulation 351-9.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 1 of 10: Overview. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 2 of 10: ET as a system alternative. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 3 of 10: The role of ET in the training system concept. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 4 of 10: Identifying ET requirements. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 5 of 10: Designing the ET component. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 6 of 10: Integrating ET with the prime system. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 7 of 10: ET test and evaluation. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 8 of 10: Incorporating ET into unit training. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 9 of 10: Logistics implications. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Research Institute for the Behavioral and Social Sciences (1988). Implementing embedded training (ET): Volume 10 of 10: Integrating ET into acquisition documentation. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

APPENDIX B

LIST OF ACRONYMS AND ABBREVIATIONS

AFV	Armored Family of Vehicles
AMC	U.S. Army Materiel Command
ASAS	All Source Analysis System
CDRL	Contract Data Requirement List
CE	Continuous Evaluation
COFT	Conduct of Fire Trainer
CPX	Command Post Exercise
DID, DIDs	Data Item Description(s)
ET	Embedded Training
ETR, ETRs	Embedded Training Requirement(s)
HIP	Howitzer Improvement Program
ILS	Integrated Logistical Support
LAN	Local Area Network
MANPRINT	Manpower and Personnel Requirements Integration
MILES	Multiple Integrated Laser Engagement System
MIL-STD	Military Standard
MOS, MOSs	Military Occupational Specialty(ies)
NET	New Equipment Training
NETP	New Equipment Training Plan
O&O	Organizational and Operational
P^3I	Preplanned Product Improvement
PEP, PEPs	Proposal Evaluation Plan(s)
RAM	Reliability, Availability, and Maintainability
RFP, RFPs	Request(s) for Proposal
ROC	Required Operational Capability
SAD, SADs	Stand-Alone Training Device(s)
SIMNET	Simulator Network
SMMP	System MANPRINT Management Plan
SOW	Statement of Work

SSEB	Source Selection Evaluation Board
SSI, SSIs	Soldier-System Interface(s)
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TOC	Tactical Operations Center
TRADOC	U.S. Army Training and Doctrine Command
WAN	Wide Area Network
WESS	Weapons Effects Signature Simulator

Working Paper

CONCEPTUAL DESIGN FOR A TASK AND TRAINING TRADE-OFF IDENTIFICATION MODEL

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CONCEPTUAL DESIGN FOR A TASK AND TRAINING TRADE-OFF IDENTIFICATION MODEL

EXECUTIVE SUMMARY

Research Requirements:

Recent research into the current requirements-based military occupational specialty (MOS) restructuring process has identified a critical need for more systematic methods and analytical tools to facilitate MOS restructuring activities. In particular, a trade-off analysis model would provide MOS analysts with a procedure to identify and evaluate potential trade-offs between the domains of manpower, personnel, and training and weapon systems features.

The purpose of the report is to present a conceptual design for a task and training trade-off identification model. Such a model would provide a systematic method for identifying trade-off issues in support of the MOS restructuring process.

Procedure:

The Task and Training Trade-off Identification Model (TIM_{TT}) is comprised of three modules: Mission Description, Data Base Development, and Trade-off Identification. The Mission Description module describes the MOS restructuring scenario and identifies training constraints that impact MOS structure decisions.

The Data Base Development module collects the task and training data necessary to describe the mission in detail and uncover the trade-off issues associated with that mission. Task and training profiles of the mission are created to feed the trade-off identification analyses that occur in the final module.

The Trade-off Identification analysis compares the training constraints determined in the initial module with the requirements determined in the second module. The results of this analysis are the trade-off issues associated with the restructuring scenario.

As an example of application of the TIM_{TT}, hypothetical data were generated for a sample set of tasks in the context of the Battlefield Maintenance System (BMS). BMS represents a MOS restructuring scenario in which the TIM_{TT} could be beneficial. The BMS data serve to illustrate the TIM_{TT} data collection and analysis process.

Findings:

The TIM_{TT} represents a conceptual trade-off methodology designed to elicit the essential trade-off issues associated with a MOS restructuring effort during the requirements-based determination of new MOS structure. As such, it uses data available during the requirements-based phase of restructuring and provides data appropriate to the outputs of that process.

Utilization of Findings:

TIM_{TT} provides a systematic way to compile data and identify trade-off issues. TIM_{TT} may be used as a basis for future development as well as a model for addressing trade-offs among other important requirements-based MOS restructuring dimensions.

CONCEPTUAL DESIGN FOR A TASK AND TRAINING TRADE-OFF IDENTIFICATION MODEL

CONTENTS

Page

List of Tables

Page

List of Figures

CONCEPTUAL DESIGN FOR A TASK AND TRAINING TRADE-OFF IDENTIFICATION MODEL

Introduction

This report documents the findings of a review and analysis of one aspect of military occupational specialty (MOS) restructuring: trade-off analysis. Specifically, the report focuses on identification of MOS task and training trade-off issues within the context of requirements-based MOS restructuring. This report is one of several reports in a research effort focusing on the development of methodologies and techniques that can be used to facilitate the restructuring of MOSs.

The focus of this research is on MOS restructuring with respect to task composition or MOS classification. Consistent with this research effort, the purpose of the report is to present a conceptual design for a task and training trade-off identification analysis to support the MOS restructuring process. The Task and Training Trade-off Identification Model (TIM_{TT}) is a method for identifying the specific task and training trade-off issues associated with a MOS restructuring scenario.

Background

The introduction of new doctrine, force structure, training, or equipment into the Army's force structure has significant implications in the area of personnel management. Such changes can alter the skill, aptitude, and training requirements of the mix of tasks that, in part, define enlisted soldiers' or warrant officers' occupations. This, in turn, can result in MOSs that can no longer fulfill the role for which they were developed. Within this environment of change, MOS restructuring is an activity that attempts to balance the effects of these changes against the need to maintain the health of affected MOSs.

MOS restructuring involves revising the task and grade composition that characterizes the MOS, merging one MOS with another, or creating an entirely new MOS. The goal of this process is to ensure that there are sufficient personnel assigned and trained within a MOS to meet Army mission requirements. This activity occurs increasingly in an environment of declining demographic trends and recruiting performance, and growing sophistication of weapon systems, all of which place a premium on the selection of the "optimal" MOS structure.

Selection of the best MOS structure involves a complex set of interconnected judgments involving doctrine, organization, equipment densities, training, demographics, personnel policy, and cost over a planning cycle extending up to seven years. At

present, the only guidance for performing MOS restructuring analyses is documented in the Guide for Preparations of Changes to the Military Occupational Classification Structure (MOCS), 1988 (commonly referred to as the MOCS Handbook). However, the MOCS Handbook provides only analytical requirements and guidance; neither systematic and quantitative analyses nor explicit procedures are provided to the MOS analyst.

While the guidelines contained in the MOCS Handbook represent a suitable basis for restructuring activities by the personnel proponent agencies, recent research into the current requirements-based MOS restructuring process has identified a critical need for more systematic methods and analytical tools to facilitate these activities (Akman and Haught, 1990).

This prior research identified a number of key areas in MOS restructuring that would benefit from more systematic methodologies. One such methodology was a MOS restructuring trade-off analysis model. A trade-off analysis model would provide the MOS analyst with a procedure to identify and evaluate potential trade-offs between the domains of manpower, personnel, and training (MPT) and weapon systems features. Furthermore, the model would determine the significance of each trade-off within the restructuring context.

Some studies have addressed aspects of the trade-off issue, if only tangentially. Recent research has identified several available analytical methodologies, or elements of methodologies, that have potential application to trade-off analysis. The focus of these methods is in the domain of systems acquisition (Steinbach, Akman, and Haught, 1990). It is not within the scope of the present study to enumerate the details of these methods but it is important to note that none were developed specifically to address the unique concerns of requirements-based MOS restructuring trade-off analysis. Such trade-off methods must use the data produced by other requirements-based MOS restructuring analyses at the level of detail these analyses provide. Although the investigation into past research on trade-off analysis was not exhaustive, the lack of findings is indicative of the absence of such research.

The present study was conducted as a step toward filling that methodological gap. Two major domains of trade-offs within the requirements-based MOS restructuring realm were chosen for analysis: MOS tasks and training. While task and training trade-offs represent a subset of all possible trade-offs in the requirements-based MOS restructuring scenario, they also represent a rich environment in which to explore possible trade-off methods. Other potential trade-off domains include manpower, personnel, and equipment system design.

Important task and training trade-off issues have yet to be explored from the standpoint of developing a systematic approach to identifying which of those issues apply to a specific restructuring scenario. The same is true for task-to-training trade-offs. For instance, the potential impacts of task structure changes on training caused by MOS restructuring are not adequately addressed. At present, only when a notional aggregated task list is submitted to the systems approach to training (SAT) process will such potentially important trade-off issues become evident. That is far too late in the MOS restructuring process. Early identification of the trade-off issues between MOS task structure and the related training is essential. If these issues are identified early in the requirements-based MOS restructuring process, modifications to the notional force structure to address the problems can be made economically.

The TIM_{TT} represents a conceptual trade-off methodology designed to elicit the essential trade-off issues associated with a MOS restructuring effort during the requirement-based determination of new MOS structure. As such, it is designed to use data available during the requirements-based phase of restructuring and provide data appropriate to the outputs of that process.

Overview of Report

This report consists of three sections. The first section discusses the goals of the trade-off methodology, the rationale for the approach, and provides an overview of the model.

The second section presents the TIM_{TT}. The section describes each module of the model in detail and provides a step-by-step guide to performing the analysis.

The last section is an example of an application of the TIM_{TT} analysis to the restructuring of maintainer MOSs as a result of the introduction of the Battlefield Maintenance System (BMS). The example examines hypothetical Ordnance Center and School data on a subset of equipment to illustrate the TIM_{TT} analysis and is intended only for that purpose.

Concepts

This section discusses the concepts behind the TIM_{TT} and presents the basis for the design of the model. The section is organized into three subsections.

The first subsection discusses the objectives of the trade-off model. The second subsection gives an overview of the model in the context of requirements-based MOS restructuring. The third subsection provides the theoretical basis for the TIM_{TT} and presents the trade-off variables examined by the model.

Trade-Off Model Objectives

The main purpose of the TIM_{TT} is to explore a method to systematically identify the potential trade-offs between MOS task structure and training within the requirements-based MOS restructuring framework. By exposing the link between task structure, and task data and training elements of that task structure, a successful trade-off identification methodology would build the foundation for objective MOS task and training decisions. The TIM_{TT} accomplishes this objective by establishing the relationship between task and training variables associated with a particular mission scenario in a systematic manner. The understanding of this relationship in the context of a particular MOS restructuring situation provides a means to quantify how changes in the task variables might affect training variables. This, in turn, leads to ways to assign tasks to MOSs on the basis of the interaction of those tasks with the training they require.

Overview of the Model

Figure 1 depicts the relationship between the TIM_{TT} and requirements-based MOS restructuring analysis. TIM_{TT} addresses the trade-off issues that are part of an overall requirements-based trade-off analysis process encompassing the domains of manpower, personnel, and training. The basic inputs to the TIM_{TT} are the outputs from many of the analyses of the restructuring process.

The TIM_{TT} is comprised of three modules: Mission Description, Data Base Development, and Trade-off Identification. The relationship between these modules is illustrated in Figure 2. The TIM_{TT} identifies the task and training trade-off issues associated with a MOS restructuring scenario. The model achieves this end by comparing the training requirements of a new mission with any constraints on that training. Trade-off issues are derived from the difference between the requirements and constraints. Training variables anchor the model analyses because many of the important limitations on MOS task structure stem from limitations in the ability or resources to train the tasks.

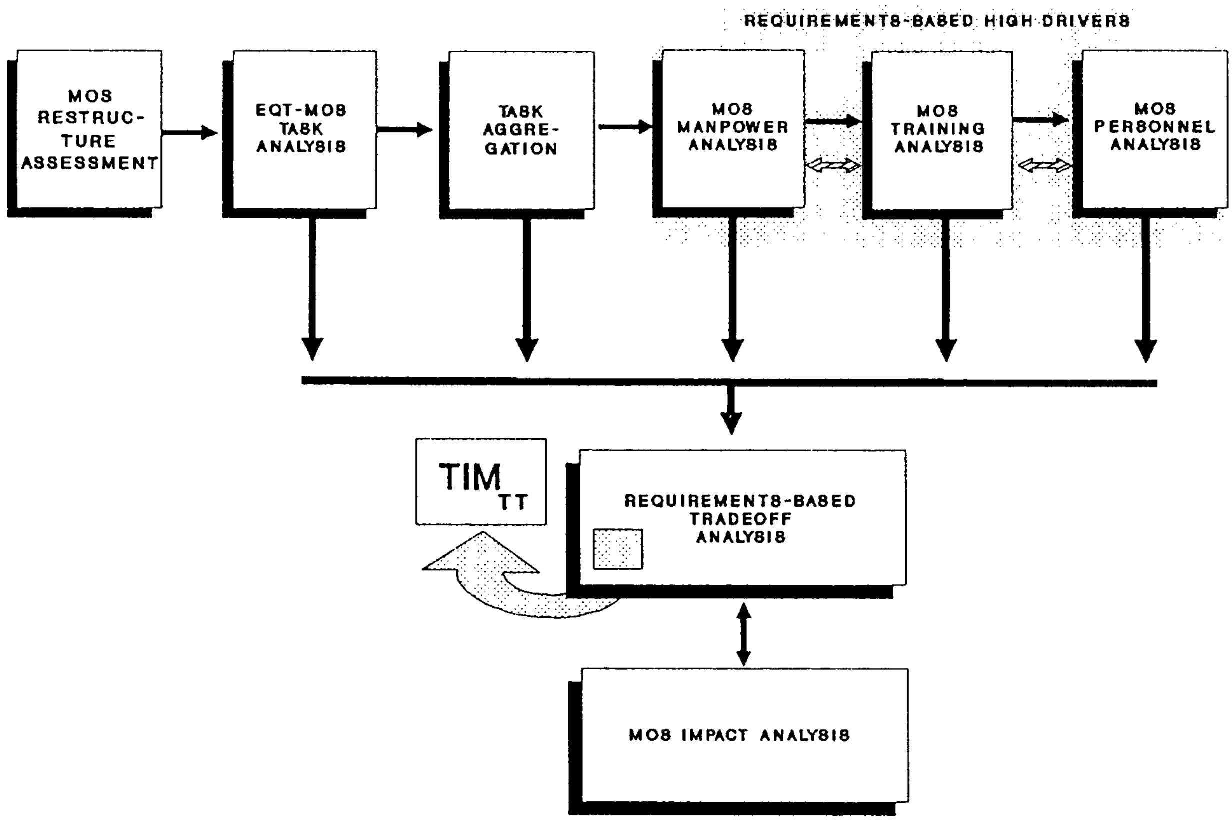

Figure 1. TIM_{TT} in the requirements-based MOS restructuring framework.

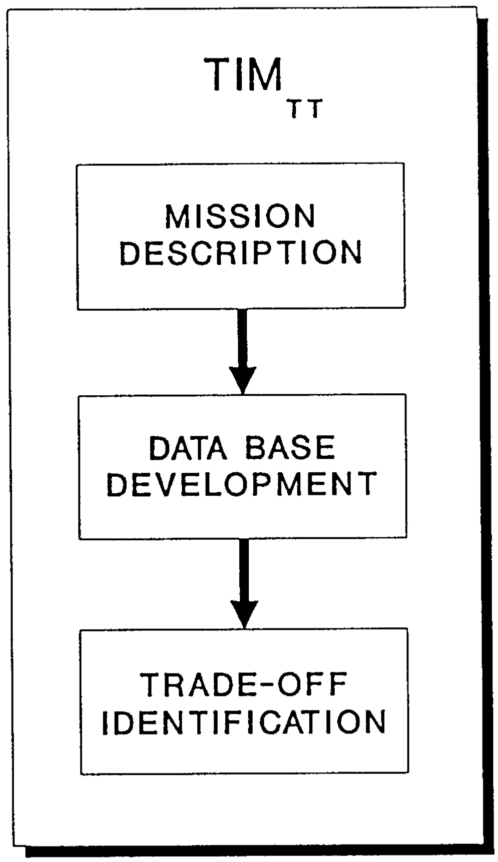

Figure 2. TIM_{TT} analysis flow.

The foundation of the model is a systems approach that uses a task analytic methodology to express mission requirements as tasks. The general training requirements of the mission are derived from these tasks in the initial phases of the TIM_{TT} and used to extrapolate the task and training trade-offs associated with that mission. Identification of trade-off issues occurs in the last phase of the TIM_{TT}. Each module of the model is described below.

Mission Description. The first part of the TIM_{TT} is the Mission Description module. The module consists of two analyses designed to describe the MOS restructuring scenario using data that will yield important task structure and training trade-offs later in the process. The first analysis involves creation of the mission profile.

The mission profile is a document that describes the mission that must be accomplished by the restructured MOS. The profile guides the trade-off analysis process by serving as the operational focal point. Every analysis and data collection effort in the TIM_{TT} attempts to address the issues described in the mission profile. This focus ensures that final trade-off analysis results are interpreted in terms of the operational mission requirements, thus ensuring that the final MOS structure can accomplish the mission. Doctrine, the operational and organizational (O&O) plan, and other background documents provide input to the mission profile. Once the profile is complete, the other analyses of the Mission Description module can be initiated.

The second analysis performed in the Mission Description module is the development of training constraints. Any constraints on the training variables implied by the mission requirements are derived from the mission profile. Known constraints to training, such as budgetary constraints and limitations on available training resources, are included in the model.

Training constraints are listed in a table. Analyses to determine mission trade-off issues, performed in the Trade-off Identification module, center on these factors.

Data Base Development. The second module of the TIM_{TT} is Data Base Development. Consisting of several steps, the Data Base Development module collects the task and training data necessary to describe the mission in detail and uncover the trade-off issues associated with that mission. Task and training profiles of the mission are created to feed the trade-off identification analyses that occur in the final module.

A mission task list is developed first. Tasks required to meet the mission are derived from the mission profile document

and compiled in a list. Once this list is completed and verified, data are collected in order to assign values to each of the task attributes. The completed task list with associated task attributes represents a mission task profile.

A mission training profile is derived from this task profile. For each task in the task profile, values are assigned to the training variables according to mission needs. When the analysis is complete, each task is accompanied by its individual training requirements, expressed as values assigned to training variables. The values are summarized across all tasks in the list. These aggregated training requirements represent the mission training profile.

Trade-off Identification. The final module in the TIM_{TT} is the Trade-off Identification analysis. Training criteria and constraints determined in the initial module are compared with task and training profiles developed in the second module to identify the trade-off issues associated with the restructuring scenario.

Trade-off Identification analysis provides the task and training trade-off issues unique to the restructuring scenario and the data with which to make task structure decisions by describing the relationship between tasks and training requirements as they pertain to the mission. The understanding of this relationship and the relative importance of each training variable allows decisions about MOS task structure to be made. Furthermore, the analysis shows the effect of this task structure on task training requirements.

Two analytical steps are performed in the analysis. The first step compares the training profile for the mission with the training criteria and constraints identified in prior analyses. This analysis exposes the potential trade-offs that pertain to the particular mission.

The second step of the analysis describes the relative impact that each of these possible trade-offs have on the mission task structure. In other words, it prioritizes the trade-offs, providing the MOS analyst with a means to choose between a number of potential trade-offs on the basis of how each potential trade-off decision will affect the mission.

Rationale for the Model

Three discussions are critical to an understanding of the rationale of the TIM_{TT}: the variables upon which the model is based, the nature of the fundamental relationships between these variables, and what MOS task structure decisions can be made based on these relationships. These topics are discussed below.

TIM_{TT} variables. Two categories of variables form the foundation of TIM_{TT} analysis: task variables and training variables. The task and training variables examined by the analysis are described below.

Task variables. The role played by task variables in the model is twofold. Task variables describe the relationship between individual tasks and the overall mission that they support. By comparing one task's variables against another's, it is possible to differentiate between tasks with respect to their support of the mission. This ability is critical to trade-off analysis.

The second role of task variables is to yield clues to how the task should be trained, what soldier abilities are necessary to perform the task, and other training requirements. In this role, the task variables operate at an aggregate level, rather than an individual level. In other words, to describe the training requirements of a group of tasks, the variables associated with those tasks are averaged across the entire group.

Certain criteria for task variables follow from their roles in the TIM_{TT}:

1. Task variables must be able to describe an individual task, since, at some point in the trade-off analysis, individual tasks will be reallocated.

2. Task variables should be able to describe the tasks defining a MOS structure as a group.

3. Since the utility of the model is directly related to its ease of use, task variables should be readily available.

Table 1 lists the seven task variables used by the TIM_{TT} and general sources for the data. With the exception of NUMBER OF TASKS, these variables can be used to describe tasks individually as well as in the aggregate. The task variables also meet the criteria for availability. As shown in the table, many variables can be collected from ready sources such as occupational survey data or Army documents.

Since most changes in equipment and doctrine are evolutionary, many tasks examined during the analysis will be similar or identical to tasks performed currently under different missions. The model assumes that the task and training attributes of these tasks are relatively stable from one mission to the next. Therefore, task data from predecessor missions and systems are used as a baseline for TIM_{TT} variables. Subject matter experts (SMEs) adjust these baseline values to match the new mission requirements. In most cases, the change is in the relative importance of a task attribute to the overall mission,

Table 1

TIM_{TT} Task Variables

Variable	Source	Description
1. ABILITIES AND SKILLS	JAAS	Rating of abilities required to perform task and amount of those abilities (skills).
2. ENABLING CRITERIA	SMEs	Measure of knowledge requirements of tasks.
3. NUMBER OF TASKS	occupational survey, SMEs, Doctrine, ECA, TMs, system contractor data	The number of tasks or sustainment tasks that in sum comprise the MOS.
4. TASK DIFFICULTY	occupational survey	Rating of relative difficulty of task.
5. TASK TIME	occupational survey, AMMHDB, MARC, MACs	Measure of amount of time required by task, relative to other tasks.
6. TOOLS/TMDE	MACs, occupational survey, SMEs, system contractor data	Description of tools and TMDE required by the task.
7. TRAINING EMPHASIS	occupational survey	Measure of importance of task to overall mission in terms of relative need to train the task during initial MOS training.

rather than in the absolute value of the attribute. For example, a maintenance task on a radio component will require largely similar maintainer knowledge in one mission scenario as in another. The importance of that maintenance task, and thus, that knowledge, may change from the first mission scenario to the second.

Values for several task variables can potentially be determined through the use of tools that are either currently available or under development. Finally, all variables can be verified by subject matter experts (SMEs). The seven task variables examined by the TIM_{TT} are described below.

ABILITIES AND SKILLS. Measures of the soldier abilities required by the mission and the amount, or skill level, in those abilities required comprise TIM_{TT}'s ABILITIES AND SKILLS variable. These data are collected through application of the Job Abilities Assessment System (JAAS).

There are 50 abilities recognized by JAAS. Abilities are organized into eight categories ranging from Communication abilities, such as oral and written comprehension, to Gross Motor abilities, such as dynamic flexibility, gross body coordination, and explosive strength (Muckler, Seven, and Akman, 1990).

Using a description of the system under analysis, such as the mission profile, and a list of tasks required to exercise that system, the JAAS identifies which of the 50 basic abilities are required to perform those tasks. Then, JAAS estimates the amount of soldier skill required in each of the selected abilities (Muckler, et al.).

JAAS is well suited for use in the TIM_{TT}. Although JAAS relies on SMEs, the method is structured, reliable, and simple enough to be self-administered.

ENABLING CRITERIA. ENABLING CRITERIA represent the knowledge requirements of a system. They are system specific; that is, the inventory of possible enabling criteria is derived from the mission (Haught and Enwright, 1990).

For each task required by a system, SMEs choose the enabling criteria associated with that task from the full list of system specific enabling criteria. The sum of these data can be illustrated as a knowledge profile that displays the enabling criteria required by the mission and the percentage of tasks in which those enabling criteria are required.

NUMBER OF TASKS. This task variable is simply a count of the total number of tasks determined to be required by the

mission. Implicit in this definition is the understanding that this variable can only describe mission tasks in the aggregate.

TASK DIFFICULTY. This variable is a measure of the relative difficulty of a task in terms of how long it takes a soldier to learn the task with respect to other tasks required by the mission. TASK DIFFICULTY ratings are produced by job incumbents and found in the occupational survey.

Although these difficulty ratings are relative to other tasks in a specific MOS, the TIM_{TT} assumes that these ratings are fairly stable independent of the MOS scenario in which they were generated. In other words, the model assumes that tasks with high difficulty ratings in one MOS will also rate high in difficulty if they appear in another MOS. The value of the rating may change from one MOS to the next, but that change will not be extreme.

TASK DIFFICULTY ratings for those mission tasks currently being performed in another mission context are used as baselines for rating TASK DIFFICULTY in the new mission context. Analysts identify the baseline ratings and SMEs verify them against the new mission, making any necessary adjustments.

TASK DIFFICULTY ratings for those tasks required by the mission but not represented in the occupational survey can be estimated by SMEs based on difficulty ratings for similar tasks in similar missions. For the purposes of the TIM_{TT}, this level of fidelity is acceptable.

TASK TIME. This variable is a measure of the relative amount of time required to perform a given task. Like the TASK DIFFICULTY data, TASK TIME data are taken from the occupational survey.

Since the TASK TIME ratings in the occupational survey are relative to tasks required for a mission different from that studied by TIM_{TT}, the TASK TIME measure may not equate to actual time required to perform the task in question. The measure is still useful for trade-off purposes, however. The model assumes that these measures, while relative to tasks in a different mission, are reasonably stable across missions. That is, a task that takes a long time to perform in one mission scenario will take a long time to perform in another, all other things being equal. For the purpose of establishing the trade-off issues associated with a mission, it is not necessary to know how long it takes to perform a particular task, just that it generally takes a long time.

TOOLS AND TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE). This variable is a listing of the tools and TMDE required to perform each task in the mission task profile. The variable generally applies to maintainer MOSs or other MOSs that have some maintenance duties, but is used to inventory any special tools or TMDE used by any MOS.

TOOLS AND TMDE required by a task are determined from MACs, POIs, occupational surveys, field manuals (FMs), and other sources. Once these data are collected for each task, an inventory of all the tools and TMDE required for the mission can be generated. This inventory gives the analyst information about the training material requirement of the mission, as well as additional insight into the soldier knowledge or skills requirements.

TRAINING EMPHASIS. TRAINING EMPHASIS is a measure of the relative importance of a task to the overall mission, as evidenced by SMEs' judgments as to when in the training process the task should be taught.

Like the TASK TIME variable, the TRAINING EMPHASIS rating of any task is relative to the other tasks in the mission scenario or MOS structure with which the task was considered during the occupational survey process. Therefore, TRAINING EMPHASIS ratings must be verified against the new mission.

Training variables. The role played by training variables in the TIM_{TT} is similar to that of the task variables. The purpose of the training variables is to provide a means to differentiate between the training requirements of different tasks in order to make decisions about MOS task structure. The variables quantify the demands of MOS task structure on training. Training variables used by the model are presented in Table 2.

The same criteria that apply to task variables also apply to training variables used in the TIM_{TT}. All of the variables in the table can be used to describe MOS training requirements in the aggregate. All but NUMBER OF TASKS can be used to describe the training requirements of individual tasks.

Although collection of data representing the training variables in the table relies heavily on SMEs, much general training data are currently available to provide guidance when assigning values to these variables for a given mission scenario. This is important since many aspects of a particular task may not change from one mission application to the next. The new mission may only change the emphasis of each variable relative to the others. Therefore, in practice, the collection of data may

Table 2

TIM_{TT} Training Variables

Variable	Source	Description
1. ASVAB SCORES	FOOTPRINT, 611-201, TAD, SMEs	Measure of ability to absorb training
2. LENGTH OF FORMAL TRAINING	POIs	Number of classroom weeks required to train tasks
3. LENGTH OF OJT	POIs, SMEs	Number of field weeks needed to train tasks
4. LENGTH OF EXPORTABLE TRAINING	POIs, SMEs	Number of weeks at other locations needed to train tasks
5. NUMBER OF TASKS	POIs, SMEs	Total number of tasks that must be trained

consist largely of verifying the training requirements of old tasks against new mission requirements. Training variables are described below.

ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) SCORES. ASVAB SCORES are generally interpreted as predictive of a soldier's ability to absorb training. They consist of an aptitude area composite and a score that indicates the level of aptitude within that area. ASVAB recognized nine aptitude areas ranging from Combat (CO) to Surveillance and Communications (SC). High scores in an aptitude area represent a greater level of aptitude than do lower scores.

ASVAB score requirements for any particular task or group of tasks must be estimated using several other task variables. The most important source for this estimate is an ASVAB requirement for similar tasks. Similar tasks are compared with the new mission and the ASVAB estimates are modified by SMEs. In addition, SMEs use training variables such as ABILITIES AND SKILLS, ENABLING CRITERIA, and TASK DIFFICULTY as further indication of the ASVAB requirements of a task or group of tasks.

LENGTH OF FORMAL TRAINING. This variable is simply an estimate of the amount of formal training, measured in weeks, that should be devoted to a particular task. The sum of all the tasks will roughly approximate the amount of formal training required to support the mission.

The length of formal training required is estimated by comparing the tasks for the new mission against similar tasks that are currently being trained. SMEs provide estimates for the few tasks that are entirely new. While not exact, these estimates are adequate for the purposes of the model and appropriate to the model's level of detail.

LENGTH OF OJT. The LENGTH OF OJT variable is an estimate of the length of formal OJT required by a task, measured in weeks. The variable is summed across all tasks in the analysis to generate an estimate of the total number of weeks of OJT required to support the mission.

Like the estimate of formal training, the LENGTH OF OJT is estimated by comparing the task requirements of the new mission with those of the old. The model assumes that similar task requirements warrant similar length of OJT. Estimates of the length of OJT required by new tasks are provided by SMEs.

LENGTH OF EXPORTABLE TRAINING. The LENGTH OF EXPORTABLE TRAINING variable is an estimate of the length of time needed to train a task outside of the classroom and OJT. The variable is

summed across all tasks in the analysis to generate an estimate of the total number of weeks of exportable training required to support the mission.

The LENGTH OF EXPORTABLE TRAINING variable is estimated by comparing the task requirements of the new mission with those of the old. The model assumes that similar task requirements warrant similar length of exportable training. Estimates of the length of exportable training required by new tasks are provided by SMEs.

NUMBER OF TASKS. This training variable is a count of the total number of tasks that must be trained in order to accomplish the mission. In the analysis, it is compared with any prior constraints on the number of tasks that a MOS can be trained to mission criteria. This variable can only describe mission tasks in the aggregate.

It is important to note that the TIM_{TT} is not limited to the use of the variables described above. In practice, some variables are eliminated from the analysis by their relative minor importance to a specific mission. At the same time, variables relevant to the mission can be added to the TIM_{TT} analyses as long as they are expressed in terms of meaningful relationships between tasks and training.

Data collection. There are many ways to assign values to task and training variables associated with specific mission scenarios. Within certain limitations, the results of the TIM_{TT} are not sensitive to how the data are collected. What is most important to the TIM_{TT} is that the data describing the mission are based in the requirements of the mission. Therefore, whether a value is assigned to a variable through some empirical analysis or by a panel of SMEs comparing current tasks against new mission requirements, as long as the values reflect actual mission needs the TIM_{TT} will produce the task and training tradeoffs associated with that mission.

The choice of the data collection method is dependent on a number of factors. Availability of data collection tools, computing equipment, SMEs, time, as well as the reliability of the data and the expense of obtaining it all contribute to the decision of how to collect data. While addressing all of these factors is beyond the scope of this document, discussing data collection techniques in general terms is appropriate.

There are several tools either under development or fully developed that potentially could provide data useful to the TIM_{TT}. Although no tools have been developed specifically to provide data for task and training trade-off analyses, the

outputs of some existing tools and techniques are consistent with the type and level of detail of data required by the TIM_{TT}. Two potentially useful tools are discussed below. This discussion is not intended to be an exhaustive critique of these methods, nor is it a comprehensive inventory. Rather, the discussion illustrates that existing data collection tools may be substituted for TIM_{TT} methods when appropriate and the choice will be dependent on the circumstances of each application of the TIM_{TT} to a mission.

One such tool is the HARDMAN III, currently under development by ARI. The HARDMAN III methodology is to be a tool to identify MPT constraints for developing weapon systems before actual system design has begun. Constraints will be developed through the use of six separate modules, one for each domain assessed by the methodology. Assessment of the impact of these constraints on system performance will influence system design. Of interest to the TIM_{TT} are the Personnel Constraints (P-CON) and Training Constraints (T-CON) modules. The first estimates personnel aptitude constraints associated with a developing system; the latter, training constraints (Kaplan and Hartel, Undated). These HARDMAN III modules, once fully developed and validated, could be useful in both determining mission constraints in the Mission Description module of the TIM_{TT} and determining task and training constraints on the mission in the Data Base Development module.

Man-Integrated Systems Technology (MIST) is a tool that supports MPT analysis by determining aspects of the MPT requirements of developing systems (Herlihy, Iceton, Oneal, et al., 1985). MIST is currently available. Like HARDMAN III, MIST analyses are performed prior to system development, which is consistent with the analyses performed by the TIM_{TT}. Specifically, elements of the MOS Selection Aid, Training Cost and Resources Determination, and Personnel Requirements Determination modules of MIST might be used to generate values for TIM_{TT} task and training variables.

Relationships between variables. There are three fundamental relationships between variables used by the TIM_{TT} inherent to the objectives of the model. These relationships describe the ways in which variables interact with one another. The first is the relationship between each of the task variables. The second is the relationship between each of the training variables. The third fundamental relationship is between task and training variables.

For the purposes of the TIM_{TT}, the nature of relationships between variables can be described in three general ways. Direct relationships are those in which the variables change in the same

direction. If the requirements for one variable increase, so do the requirements for the other. Inverse relationships are those in which the variables change in opposite directions. In inverse relationships, an increase in the requirements of one variable would cause a corresponding decrease in the requirements of the other. Finally, relationships between some variables can be characterized as situational. Such relationships can be either direct or inverse, depending on the mission context. In other words, the increase in requirements for one variable may result in an increase in the related variable under one mission context and a decrease in another context.

Relationships between task and training variables, their roles in the TIM_{TT}, and their impacts on MOS restructuring are discussed below.

Relationship between task variables. Within the task category of variables examined in the TIM_{TT}, there are many potential interactions that have implications for MOS task structure trade-offs. These are presented in the matrix in Table 3.

Table 3 is a guideline for the potential interactions between task variables that generally apply to aggregated MOS tasks as well as to individual tasks. The table shows which task variables are related, and thus, interact, and the nature of the relationships. The table is only a guideline because interactions vary with the unique context of the mission. For instance, in a context in which there are many heavy lifting tasks, TASK DIFFICULTY will not interact with ENABLING CRITERIA, as the value assigned to the TASK DIFFICULTY variable will reflect the amount of physical effort required to perform the task. In a mission context that requires significant cognitive processing, such as troubleshooting complex electronic equipment, TASK DIFFICULTY may be strongly related to the ENABLING CRITERIA value. In this case, the complex task requires extensive knowledge.

Since the analysis identifies the mission-specific trade-off issues by comparing task-driven training requirements with training constraints, it does not directly identify task-to-task relationships specific to the mission. Rather, the task-to-task relationships described provide insight into how changes in one task variable might affect other task variables.

Relationship between training variables. There are many potential interactions between variables within the training category. The matrix presented in Table 4 shows the potential interactions between training variables with respect to MOS task training and the nature of those interactions.

Table 3

Relationship Between Task Variables

TASK VARIABLES	ENABLING CRITERIA	NUMBER OF TASKS	TASK DIFFICULTY	TASK TIME	TOOLS & TMDE	TRAINING EMPHASIS
ABILITIES & SKILLS	D	S	D		D	
ENABLING CRITERIA			D		D	
NUMBER OF TASKS			S	S		D
TASK DIFFICULTY				S	D	
TASK TIME						S
TOOLS & TMDE						
TRAINING EMPHASIS						

LEGEND

D - Direct

I - Inverse

S - Situational

Table 4

Relationship Between Training Variables

TRAINING VARIABLES	L. FORMAL TRAINING	LENGTH OF OJT	L. EXPORT TRAINING	NUMBER OF TASKS
ASVAB SCORES	D	D	D	D
L. FORMAL TRAINING		S	S	S
L. OF OJT			S	S
L. EXPORT TRAINING				S
NUMBER OF TASKS				

LEGEND

D - Direct
I - Inverse
S - Situational

The table presents general guidelines describing the types of interactions between training variables that apply to aggregated MOS tasks as well as individual tasks. Like the relationships between task variables, the interactions between training variables vary with the context of the mission because they represent unique mission requirements.

An example of situation-specific variability is the change in the nature of the relationship between LENGTH OF FORMAL TRAINING and LENGTH OF OJT under different mission circumstances. In one scenario, lengthy formal training may decrease the need for OJT. This would be an inverse relationship. However, in another scenario, a task may require lengthy formal training, perhaps theoretical in nature, and extensive OJT to turn the theory into practical experience. In this case, the nature of the relationship between the two would be characterized as direct.

<u>Relationship between task and training variables</u>. Crucial to the TIM_{TT} is an understanding of the fundamental relationship between tasks and their training requirements. The mission objectives drive the tasks that must be performed to accomplish the mission. These tasks determine the training requirements of the mission. The model recognizes this dependant relationship by using a mission profile to develop a task list from which the task training requirements are determined.

Table 5 presents the relationships between task and training variables in a matrix. The table represents a guideline for the types of trade-off issues potentially revealed by TIM_{TT} analysis. For example, analysis may discover that the training requirements of the MOS tasks needed to meet a mission exceed the predetermined training constraint on the aggregate ASVAB score requirements. As illustrated in the table, the trade-off issues would center on the trade-offs between ASVAB scores and the task variables of ABILITIES AND SKILLS, ENABLING CRITERIA, NUMBER OF TASKS, TASK DIFFICULTY, and TOOLS AND TMDE. Potential trade-offs would consist of manipulating task structure to change the aggregate values assigned to these task variables. One or all of the task variables could be altered to meet the training constraints.

<u>Rationale for MOS task structure decisions</u>. Every MOS restructuring decision is influenced by a large number of potential task and training trade-offs. For example, if preliminary analysis determines that the notional MOS demands a large proportion of soldiers in the higher mental categories, there are a number of ways to reduce this demand through changes in the notional task structure. These types of changes fall into the category of "task versus training" trade-offs. Task

Table 5

Relationship Between Task and Training Variables

TASK VARIABLES		TRAINING VARIABLES				
		ASVAB SCORES	L. FORMAL TRAINING	LENGTH OF OJT	L. EXPORT TRAINING	NUMBER OF TASKS
	ABILITIES & SKILLS	D	I	I	I	
	ENABLING CRITERIA	D	D	D	D	
	NUMBER OF TASKS	D	D	D	D	D
	TASK DIFFICULTY	D	D	D	D	
	TASK TIME		D	D	D	
	TOOLS & TMDE	D	D	D	D	
	TRAINING EMPHASIS		D	D	D	D

LEGEND

D - Direct

I - Inverse

S - Situational

structure can be changed to lower the aggregate abilities and skills requirements. The number of tasks that require some theoretical knowledge, such as an understanding of the principles of electricity, can be reduced. Similarly, the total number of tasks can be reduced. These changes in task structure reduce the number of tasks that demand extensive training resources, allowing a greater proportion of the total training time to be devoted to the remaining complex tasks.

In addition, trade-offs in the "training versus training" category may be required at the same time. In fact, trade-offs within one category are often related to those in another. For instance, using the same example, while the notional task structure demands high ASVAB scores, it also may require too many weeks of formal training. Some of the same changes in task structure used to solve the first problem could reduce the length of training needed. Changing task knowledge requirements and abilities and skills requirements could lower the amount of time needed to teach the tasks. Other trade-off options are also available. Reducing the overall amount of time required to perform tasks might decrease training time. Deleting tasks from those trained at a particular stage of MOS training can also reduce the length of time needed to train the remaining tasks.

In sum, a MOS restructuring analyst is confronted with a potentially bewildering array of possible trade-offs. The TIM_{TT} analysis attempts to address this problem by identifying those potential trade-offs that specifically apply to the restructuring scenario and differentiating between these trade-offs on the basis of their potential impact on the mission.

The trade-off decision process used by the TIM_{TT} follows from two related assumptions. The first is that the ways in which task and training variables relate to each other to form potential trade-offs may vary from one mission to the next. The second assumption is that the impacts these trade-offs will eventually have on mission task structure vary from mission to mission.

Each training variable is given a rating that expresses its importance to the mission relative to the other training variables. Then, trade-off issues specific to the MOS restructuring scenario are derived from the comparison between the training profile and the training constraints. This results in a list that displays those trade-offs that pertain to the restructuring scenario in order of precedence. This list is a guideline for actually performing the trade-offs. Since trade-offs are interrelated, those trade-offs with the greatest precedence should be performed before trade-offs with the least precedence. That is, the trade-offs with the greatest impact on mission function should constrain those trade-offs with the least impact. In this way, the TIM_{TT} creates a blueprint for performing MOS task structure trade-offs.

TIM_{TT} Analysis

The purpose of this section is to describe the TIM_{TT} application process. The three components, or modules, of TIM_{TT} are: Mission Description, Data Base Development and Trade-off Analysis. Figure 3 illustrates the information flow of the TIM_{TT} analysis in detail. Each module and its component parts is discussed in the following subsections.

Mission Description

The goal of the Mission Description module is to describe the operational mission in terms of the tasks required to meet the mission and the training required to ensure the tasks can be performed. The module consists of two analytic components: development of a mission profile and development of training constraints.

Development of a mission profile. The goal of the mission profile is to define the mission scenario in terms of what is required to accomplish the mission. The output from this process will be used to guide the balance of the analyses performed during application of the TIM_{TT}. Table 6 presents the steps in development of the mission profile.

The first step is to collect relevant data. There is no standard source for this data; however, the minimum inputs to the mission profile should be the appropriate doctrine, the O&O, current MOS tasks, new equipment contractor task data, and related technical manuals. Additional inputs could be MACs, early comparability analysis (ECA) tasks, and Sections 1, 2, and 3 of the appropriate Tables of Organization and Equipment (TOEs).

The objectives of the mission are determined from these documents. To ensure that the analysis is focused on task and training trade-off issues, these objectives are stated as general MOS task structure and training criteria.

The mission profile is essentially a job description or set of job descriptions. The first part of the document consists of a brief background section describing the force structure or other change or performance deficiency that initiated the MOS restructuring process. The rest of the document describes the job to be performed by the MOS or MOSs including, at a minimum, the following:

1. A description of the task functions encompassed by the job. For example, a maintenance MOS may be responsible for task functions of "Inspect", "Repair", "Replace", "Service", and so on.

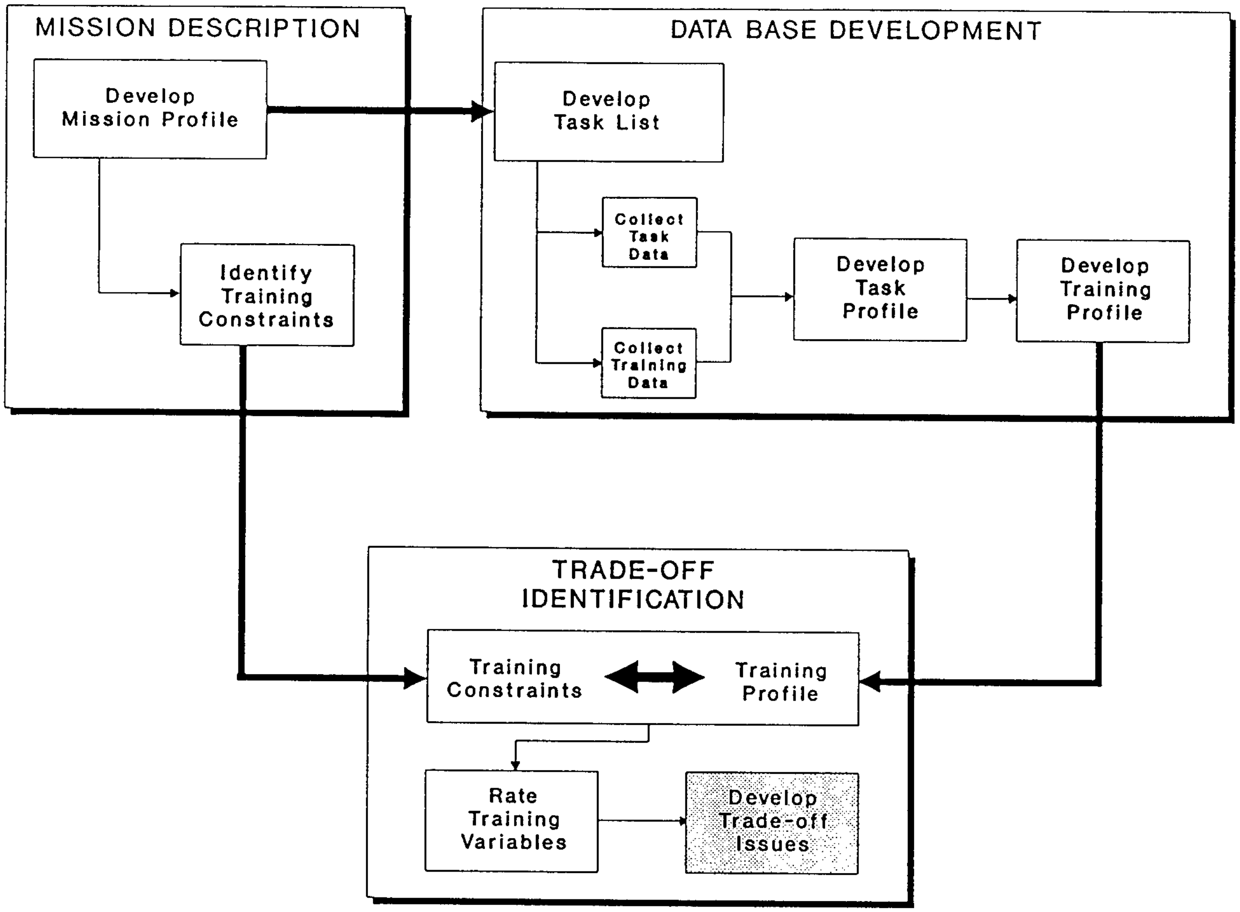

Figure 3. Detailed TIM_{TT} analysis flow.

Table 6

Develop Mission Profile

Goal: Define the scenario in which the MOS restructuring will occur in terms of mission requirements

Inputs: Notional MOS description from previous analyses, doctrine, O&O, maintenance materials, etc.

Procedure:

1. Assemble relevant documents

2. Define MOS restructuring objectives; state as specific criteria

3. Develop mission profile document describing mission and the MOS requirements to meet the mission

    a. List and describe task functions
    b. List and describe locations in which tasks will be performed
    c. List and describe equipment, tools, and TMDE
    d. List and describe physical activities
    e. List and describe supervisory functions

Output: Mission profile document

Resources: Analysts, SMEs

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2. A description of the locations in which the job will be performed, including the environmental aspects of those locations (e.g., extreme heat or cold, etc.).

3. General discussion of the equipment used in the course of job performance.

4. General description of the physical activities.

5. General description of the supervisory activities.

Identification of training constraints. Once the mission profile has been defined, it is necessary to identify any constraints on those training variables used by the TIM_{TT} analysis. Table 7 presents the steps in this analysis and the associated inputs, outputs, and resource requirements.

The first step is to identify which of the training variables presented in Table 2 are constrained and why they are constrained. Constraints on training can take a number of forms: budgetary, restrictions in available equipment, classrooms, and many other reasons. Those constraints associated with the mission area under review that can be identified must be expressed in terms of the training variables that they affect. For example, a mission requirement for a large proportion of high ASVAB scores may be constrained by the distribution of ASVAB scores found in the general enlisted and recruit population. Since the distribution of mental categories across the population of soldier and recruits is known, constraints on the ASVAB scores for a particular application can be determined.

Once the constraints are identified, the second step is to assign descriptive values to the training variables that are constrained. For example, values associated with the ASVAB constraint would be expressed as the actual number of enlisted and recruits available in each mental category. The values are compared with those developed for the training profile for the mission determined in later phases of the analysis. The comparison of training constraints with the training profile yields the trade-off issues associated with the MOS restructuring scenario.

Data Base Development

The second major element of the TIM_{TT} is the Data Base Development module. This module collects mission related task and training data to assemble task and training profiles.

Table 7

Develop Training Constraints

Goal:	Identify training constraints, based on the mission profile
Inputs:	Mission profile document, training materials, SMEs, budget documents, other relevant documents
Procedure:	1. Compare the training variables (Table 2) with the mission profile to determine which variables are constrained and why (e.g., ASVAB scores may be constrained by the percentage of certain ASVAB categories represented in the general population of recruits) 2. Assign values to the training variables for those variables that are constrained (e.g., mental category requirements must conform to the mental category distribution of recruits)
Output:	List of training constraints required by fiscal, operational, manpower, etc., requirements and limitations
Resources:	Analysts, SMEs

Develop mission task list. The mission task list consists of all tasks required to accomplish the mission. Using the mission profile as guidance, the tasks required by the mission are identified and assembled into a data base. Then, task description data required by the TIM_{TT} are collected for each task. This process is outlined in Table 8 and described in detail below.

Identify the mission required tasks. The first step in task profile development is to identify all of the tasks that must be performed to accomplish the mission. SMEs review all tasks associated with predecessor equipment systems and operational procedures against the mission profile to determine whether they apply to the new mission. If old tasks are not available to cover certain parts of the new mission, SMEs create new tasks.

In many applications of the TIM_{TT}, input to the model will be a notional MOS developed in the requirements-based MOS restructuring process. This notional MOS will be defined by a list of tasks. In these cases, the notional MOS tasks should be verified against the mission profile to ensure that the mission can be accomplished given that set of tasks.

Identify the mission sustainment tasks. It is desirable to limit the analysis to only those data that have major bearing on the mission for two reasons. The first is that MOS restructuring decisions must be based on data immediately relevant to meeting the battle mission. Any tasks that have limited impact on the ability of an equipment system or MOS to fight should have limited importance in the MOS restructuring decision. Tasks with the greatest impact on equipment systems' or MOSs' ability to fight should have precedence over other tasks.

The second reason to limit the number of tasks considered in the analysis is one of economy. It is easier to collect data related to a smaller number of tasks. It is also easier to analyze the lesser volume of data.

Based on these reasons, the mission task list is screened to identify those tasks that are required to sustain the system in battle. Sustainment tasks represent the minimum set of tasks needed to ensure the mission can be accomplished. The list of sustainment tasks resulting from this review will be a subset of the original set of tasks.

Sustainment tasks are determined by SMEs. The SMEs develop sustainment criteria from the mission profile. The criteria are guidelines that represent the minimum needs of the system in battle. For example, the sustainment criteria for a mission requiring a radar system would include generator tasks necessary

Table 8

Develop the Mission Task List

Goal:	Identify the sustainment tasks associated with the mission.
Inputs:	Task lists, (task data sources), mission profile
Procedure:	1. Identify tasks required by the mission. a. Compare predecessor system tasks against mission profile b. List tasks from predecessor systems that approximate new mission requirements c. Create new tasks to meet mission requirements, as appropriate 2. Identify sustainment tasks a. Develop sustainment criteria b. Apply criteria to task list c. Assemble tasks that meet criteria into sustainment task list
Outputs:	Mission oriented sustainment task profile
Resources:	Analysts, SMEs

to ensure a steady power supply. However, tasks related to the repair of chassis shock absorbers would be excluded.

Once sustainment criteria are developed, the SMEs determine which tasks meet these criteria and include them in a list of sustainment tasks. Sustainment tasks are the foundation of the rest of the TIM_{TT} analyses.

Collect task profile data. The next step of the Data Base Development is to collect the data necessary to quantify those task variables identified by analyses performed during the Mission Description step as relevant to the mission. The purpose of this step is to collect the data that will serve as a baseline description of the mission task requirements. This baseline is expressed as a mission task profile that is used to derive the training requirements of the mission.

Data collection procedures are outlined in Table 9. The data collection procedures for each task variable are described in detail below.

ABILITIES AND SKILLS. These data are inventories of the abilities (perceptual, cognitive, motor, etc.) required by the mission and the amount, or skill level, of those abilities required. The abilities and skills requirements for each sustainment task are collected and entered into the data base with the other task data.

ABILITIES AND SKILLS data are collected through application of the JAAS methodology. JAAS is a flexible tool that can identify the abilities and skills demands of a system (Muckler, et al.).

An abilities and skills requirements profile for the general mission is generated once abilities and skills requirements have been determined for all tasks. This profile is a composite of the individual tasks' requirements and is used to estimate general training requirements later in the TIM_{TT} analysis.

ENABLING CRITERIA. Enabling criteria represent the knowledge requirements of the tasks in the sustainment task list. The knowledge requirements of each sustainment task are assessed by SMEs, expressed as enabling criteria, and entered into the data base (Haught and Enwright, 1990).

ENABLING CRITERIA data collection is a three step process. The first step is to convene a panel of SMEs familiar with the objectives and equipment systems of the new mission. Panel

Table 9

Collect the Task Profile Data

Goal:	Collect the descriptive data associated with the seven task variables used by the TIM_{TT}.
Inputs:	Mission sustainment task list
Procedure:	1. Collect abilities and skills data a. Apply JAAS to task list b. Record JAAS data in task data base 2. Collect enabling criteria data a. Assemble SME panel b. Inventory the mission knowledge requirements and express as enabling criteria c. Assign enabling criteria to each task d. Record enabling criteria data in data base 3. Collect task difficulty data a. Identify which mission tasks are currently performed in other mission contexts b. For these tasks, collect occupational survey task difficulty rating scores c. Verify scores against new mission requirements d. Assign scores to new tasks using occupational survey procedure e. Record task difficulty ratings in data base 4. Collect task time data a. Identify which mission tasks are currently performed in other mission contexts b. For these tasks, collect occupational survey task time rating scores c. Verify scores against new mission requirements d. Assign scores to new tasks using occupational survey procedure e. Record task time ratings in data base 5. Collect tools and TMDE data a. Identify which mission tasks are currently performed in other mission contexts b. Inventory tools and TMDE required for these tasks c. Estimate tools and TMDE required for new tasks d. Record tools and TMDE in data base 6. Collect training emphasis data a. Identify which mission tasks are currently performed in other mission contexts b. For these tasks, collect occupational survey task training emphasis rating scores c. Verify scores against new mission requirements d. Assign training emphasis scores to new tasks using occupational survey procedure e. Record task training emphasis ratings in data base 7. Count the number of sustainment tasks in the data base
Outputs:	Data base of sustainment tasks and their associated mission related requirements expressed as values assigned to seven task variables
Resources:	Analysts, SMEs, various task data sources (occupational survey, ECA, TMs, MACs, etc.)

members should be briefed on the details of the mission to ensure that each panel member has the same understanding of the mission criteria.

The second step is to create an inventory of enabling criteria associated with the mission. SMEs derive the basic mission-specific knowledge requirements from the mission profile. For example, a mission involving repair of signal equipment would demand knowledge of electricity, knowledge of electronic troubleshooting, knowledge of electronic tools and TMDE. These are identified, defined, and independently verified. The output of this step is a list of enabling criteria with definitions that describes all of the knowledge requirements needed for the mission.

The last step in the ENABLING CRITERIA data collection process is to assign enabling criteria to the sustainment tasks. The SME panel identifies which enabling criteria are required for each task. The list of enabling criteria associated with each task is entered with those task in the data base.

Later in the TIM_{TT} analysis, the composite set of mission enabling criteria are used to determine the general knowledge training requirements of the mission. Enabling criteria of individual tasks are used to identify those tasks that demand training that is not compatible with the previously determined constraints on training.

NUMBER OF TASKS. The NUMBER OF TASKS variable is simply a count of the number of sustainment tasks required by the mission. The count is performed after all of these tasks have been identified.

TASK DIFFICULTY. TASK DIFFICULTY is a rating of the relative difficulty of a task. Ratings for each sustainment task are either collected from available sources or generated and entered in the data base.

TASK DIFFICULTY ratings may be found in occupational surveys. Since a large number of sustainment tasks for the new mission will be similar or identical to tasks for existing missions, difficulty ratings for these tasks may be available. In these cases, difficulty ratings for current mission tasks are recorded for similar new mission sustainment tasks and entered in the data base. These baseline difficulty ratings are reviewed against the new mission by SMEs to ensure they are consistent with the mission. Finally, difficulty ratings for any new tasks are generated by SMEs using the survey procedure which rates task difficulty on a seven-point scale ranging from "Extremely Low Difficulty" to "Extremely High Difficulty".

A composite TASK DIFFICULTY score is generated once all tasks have been rated. This score represents an average of task difficulty for the mission which is compared with training constraints. Difficulty ratings of individual tasks are then used to identify difficult tasks.

TASK TIME. TASK TIME is a rating similar to task difficulty. Like the task difficulty measure, TASK TIME is a relative rating, rather than an absolute measure of the amount of time required to perform a task.

TASK TIME ratings may also be found in occupational surveys. The data collection process is identical to that of the task difficulty variable. TASK TIME data are collected for each task and entered into the data base.

An average TASK TIME score is computed for the mission sustainment tasks to be compared against the training constraints in a later stage of the TIM_{TT} analysis. Individual TASK TIME values are used to identify high driver tasks.

TOOLS AND TMDE. This variable represents the tools and TMDE required for each task in the mission sustainment task list. Tools and TMDE are identified and entered into the task data base.

These data are available from a number of sources. For maintenance missions, tools and TMDE for tasks are found in MACs for specific items of equipment. For all categories of missions, POIs for similar MOSs and systems contain lists of required tools and TMDE. Finally, technical manuals (TMs) describe tools and TMDE.

TRAINING EMPHASIS. TRAINING EMPHASIS is a measure of the relative need to train a particular task during initial MOS training. A high TRAINING EMPHASIS rating is a clue to the importance of a task to the mission, personnel safety, or a reflection of the relative number of times that task will be performed by a MOS incumbent. TRAINING EMPHASIS data for each task in the mission sustainment task list are collected and entered in the database.

The data may be available from occupational surveys. The data collection procedure is identical to that of the TASK DIFFICULTY and TASK TIME variables. TRAINING EMPHASIS values for tasks not in occupational surveys are generated by SMEs. SMEs rate TRAINING EMPHASIS on a seven-point scale that ranges from "Very Low Emphasis" to "Very High Emphasis".

In later TIM_{TT} analysis, composite scores of TRAINING EMPHASIS are compared with training constraints. Individual scores are used to identify high driver tasks in the sustainment task list.

Create mission task profile. The mission task profile summarizes the task data collected. The profile is created by averaging the values for each variable across all tasks and displaying the averages in a table. This summary table is used to develop the training profile in a later stage of TIM_{TT} analysis.

Develop the mission training profile. The training profile is a description of what is required to train the mission tasks. Training profile development involves determining the training requirements of each mission task in terms of the TIM_{TT} training variables. Then, aggregate training requirements are summarized from these individual requirements and compared with the mission training criteria and constraints determined in the Mission Development step.

Each variable upon which data are derived is discussed below. Table 10 summarizes the procedures for deriving the training requirements from the mission task profile.

ASVAB SCORES. The ASVAB SCORES needed to perform tasks are estimated by SMEs. SMEs use two major sources of data to make judgments about the ASVAB scores each task requires.

The first is based on comparison of the new MOS with old MOSs. SMEs first identify the ASVAB aptitude area required by the new mission. Then, they find current MOSs that have similar missions to the new MOS and also require this same ASVAB aptitude area. Next, the SMEs make an estimate of the ASVAB score required by the new mission by examining the range of scores required by the other MOSs. These data are found in the AR 611-201.

For example, SMEs initially judge the new mission to require an ASVAB aptitude area of EL (electronics). Then, they list all MOSs that both require the EL aptitude and have missions similar to the new MOS. Next, the SMEs note the range of ASVAB score requirements of the MOSs in the list (85 to 110). Finally, the SMEs estimate where in that range of scores the new MOS falls.

The second source of data used to make judgments is a subset of the task data collected to build the task profile, such as ABILITIES AND SKILLS, ENABLING CRITERIA, and TASK DIFFICULTY.

Table 10

Create the Mission Training Profile

Goal: Describe the mission training requirements in terms of the TIM_{TT} training variables.

Inputs: Mission profile, mission task profile, mission task list

Procedure:

1. Estimate the ASVAB SCORES requirements
   a. Estimate primary ASVAB aptitude area(s) required by mission
   b. Estimate mission ASVAB score based on similar missions
   c. Estimate scores for individual tasks based on similar tasks and mission task variable values

2. Determine the LENGTH OF FORMAL TRAINING requirements
   a. Identify current tasks similar to tasks for mission under study
   b. Estimate length of formal training required for each mission using current task training as a guide
   c. Estimate training requirements for mission tasks for which there are no similar current tasks

3. Determine the LENGTH OF OJT requirements
   a. Identify current tasks similar to tasks for mission under study
   b. Estimate length of OJT required for each mission using current task training as a guide
   c. Estimate training requirements for mission tasks for which there are no similar current tasks

4. Determine LENGTH OF EXPORTABLE TRAINING requirements
   a. Identify current tasks similar to tasks for mission under study
   b. Estimate length of exportable training required for each mission using current task training as a guide
   c. Estimate training requirements for mission tasks for which there are no similar current tasks

5. Count the NUMBER OF TASKS that must be trained.

These data are used to support the initial judgments based on total mission ASVAB aptitude area and score requirements and to translate those general judgments into estimates for individual tasks.

Once the ASVAB requirements for the new mission have been identified, SMEs estimate the requirements of each task. SMEs modify the aptitude area and score requirement for the aggregated tasks using the individual task data. For example, if the score for the mission is a minimum of 95 in aptitude area EL, SMEs adjust this number upward or downward, as appropriate, for each task in the list. Some tasks will require a minimum score much lower than 95. Tasks that have high ratings in one or all variables of ABILITIES AND SKILLS, ENABLING CRITERIA, and TASK DIFFICULTY may require a higher score.

LENGTH OF FORMAL TRAINING. This variable describes the amount of classroom time required to train a particular task. The value is determined by SMEs in several steps.

First, SMEs identify mission tasks that are similar or identical to current tasks. The amount of training required for the current tasks, found in the POI containing the task, is verified against the new mission. SMEs either accept the old value or adjust it for the new mission and record the value for that mission task. This process is repeated for all mission tasks that can be matched with current tasks.

Second, SMEs estimate the amount of formal training required for each of those tasks that are entirely new. This estimate is based on the SMEs' experience.

LENGTH OF OJT. This variable describes the amount of supervised training in the field required to train a particular task. This value is determined by SMEs in the same way as that for LENGTH OF FORMAL TRAINING.

LENGTH OF EXPORTABLE TRAINING. The length of exportable training required by a particular task is estimated by SMEs in the same way as the LENGTH OF FORMAL TRAINING and OJT.

NUMBER OF TASKS. This is simply a count of all tasks that must be trained.

Summarizing the training data. Once training requirements are determined for all individual tasks in the mission task list, they are summarized to create the training profile. Like the mission task profile, the training profile presents a value for each training variable that represents an average of values for each variable across all tasks. These aggregate values are

recorded in a table that is compared with the previously determined training constraints during the Trade-off Identification step.

__Trade-Off Identification__

The goal of the Trade-off Identification step is to identify the specific trade-off issues related to the MOS structure necessary to meet the mission requirements. Trade-off issues identification is comprised of two steps: identify the training problems and choose the mission-relevant trade-off issues. These steps are described below.

__Identify the training problems__. In the first step of trade-off issues identification, the training requirements identified during the Data Base Development step are compared against the training constraints identified during the Mission Description step. The differences between the training requirements of the mission tasks and the constraints on training yields the general trade-off issues associated with the mission.

For each aggregated training variable in the training profile, the analysis asks the question: Is the value within the training constraints? The analysis is simply a calculation of the difference between the variables: the difference between average ASVAB SCORES requirements and the ASVAB SCORES constraints, the average LENGTH OF FORMAL TRAINING and the constraints on length of training for the mission, and so on. These calculations are displayed in a table as shown in Table 11.

__Identify the mission-relevant trade-offs__. The next step is an analysis process that translates the results of the comparison of the training profile with the training constraints into the specific trade-off issues associated with the mission. The analysis identifies the trade-off issues, describes how they are related, and creates a trade-off table that can be used as an analytical tool in performing trade-off analyses.

The analysis consists of two steps. In the first, SMEs rate each training variable on its relative importance to the mission. In the second step, a mission specific trade-off table is created. The table provides MOS restructuring analysts with a tailored summary of all potential task and training trade-offs, organized by the significance of each possible trade-off decision to the overall mission. The two steps in this analysis are described below.

__Rate the training variables__. The five training variables used in the TIM_{TT} study are rated according to their importance to the overall mission. A SME panel is presented with a survey

Table 11

Comparison Between Training Requirements and Training Constraints

Variable	Training Constraint	Training Requirement	Difference
ASVAB SCORES	#	#	#
LENGTH OF FORMAL TRAINING	#	#	#
LENGTH OF OJT	#	#	#
LENGTH OF EXPORTABLE TRAINING	#	#	# #
NUMBER OF TASKS	#	#	#

used to rate training variables on a seven point scale, with a seven representing the greatest significance to the mission and a one, the least. SMEs are instructed to make their selections in relation to the other training variables. In other words, the highest rating of the group of variables indicates that it has greater significance to the mission than the other variables.

Build the trade-off table. The trade-off table is a summary of the results of all the TIM_{TT} analyses that is designed to guide the MOS restructuring analyst by consolidating several critical data related to the restructuring scenario. Table 12 shows an example of a trade-off table and the type of information it contains.

The first step in building the table is to list the problems identified in the requirements versus constraints analysis in descending order of their importance, as determined by SME ratings of the training variables. Differences between training requirements and constraints are presented as problem statements in the trade-off tables such as "The aggregate ASVAB SCORES requirements exceed the constraints on ASVAB SCORES". Problem statements are listed in the first column of the trade-off table.

The second step in building the table is to list the range of corrective actions that can be taken to solve the problem. Corrective actions are the possible trade-off decisions. They consist of two elements: a variable and the direction in which that variable must change to correct the problem. Corrective action statements take the form of instructions to analysts, such as, "Decrease the aggregate TASK DIFFICULTY" or "Decrease the aggregate knowledge requirements".

Corrective actions used in the table are based on the relationships between TIM_{TT} variables found in Tables 3, 4 and 5. The tables identify which task and training variables are related and the nature of that relationship. For the purposes of the TIM_{TT} there are two categories of corrective actions, or trade-offs: trade-offs within MOS training and trade-offs between MOS tasks and training. Corrective actions are sorted by these categories in the trade-off table. There are no task versus task trade-offs because the problem statement is presented in terms of training variables. Thus, corrective actions are necessarily derived in terms of the variables that must be manipulated to affect training.

Both the identification of which variables are related and the description of the nature of those relationships are used to build the corrective action portion of the trade-off table. The

Table 12

Sample Trade-Off Table

Problem	Corrective Actions
	Training vs. Training
ASVAB scores required exceed constraints	1. Increase length of formal training 2. Increase length of OJT 3. Increase length of exportable training 4. Decrease number of tasks
	Task vs. Training
	1. Decrease abilities and skills requirements 2. Decrease enabling criteria 3. Decrease number of tasks 4. Decrease task difficulty 5. Decrease number and complexity of tools and TMDE required

variable is identified first, then, the direction the variable must change to correct the discrepancy between the training requirements and constraints is determined.

For each training variable for which a discrepancy between requirements and constraints has been identified, analysts identify the related task and training variables from Tables 4 and 5. For example, if the affected training variable is ASVAB SCORES, the analyst determines which task variables and other training variables are related from Tables 4 and 5. Table 4 shows that ASVAB SCORES are related to other training variables of LENGTH OF FORMAL TRAINING, LENGTH OF OJT, LENGTH OF EXPORTABLE TRAINING, and NUMBER OF TASKS. Table 5 shows that ASVAB SCORES are related to task variables ABILITIES AND SKILLS, ENABLING CRITERIA, NUMBER OF TASKS, TASK DIFFICULTY, AND TOOLS AND TMDE.

All variables found in these tables that are related to ASVAB SCORES are recorded by category in the corrective actions column of the trade-off table. Thus, once this portion of the analysis is completed, the trade-off table has the "Problem" column filled. The "Corrective Actions" column contains the specific variables that can be manipulated to address the problem.

The next step is to determine the direction in which the variables must change to address the problem. Direction is derived from the nature of the relationship between variables, which is indicated by the code in the cells of Tables 4 and 5. The analyst translates the general description of the nature of the relationship into a specific action such as "Increase" or "Decrease", as appropriate.

Using the example in which ASVAB SCORES exceed the constraints, the analyst determines that these scores are inversely related to the training variable LENGTH OF FORMAL TRAINING. In this case, to decrease the ASVAB score requirements, the length of training would have to increase. At the same time, ASVAB SCORES are directly related to the task variable of ABILITIES AND SKILLS. Therefore, another way to decrease ASVAB SCORE requirements is to change the task structure to lower the overall abilities and skills requirements of the mission tasks.

In this manner, the analyst combines the related variables with the appropriate direction of change to complete the corrective action statements. These statements are recorded in the trade-off table under the appropriate trade-off category:

training versus training or task versus training. This process of translating the relationships in the table to corrective action statements is repeated until all variables that apply for the scenario under study are accounted for.

In sum, TIM_{TT} provides a systematic way to compile data and identify trade-off issues. TIM_{TT} may be used as a basis for future development as well as a model for addressing trade-offs among other important requirements-based MOS restructuring dimensions.

TIM_{TT} Application to Track Automotive Transmission Repair

This section provides a sample application of the TIM_{TT} to track automotive transmission repair. The information and findings provided in this section are based on hypothetical data and are used for the purposes of illustration only. The section is organized into five subsections.

The first subsection provides a mission description of track automotive transmission repair performed at the field repair (FR) level of maintenance governed by the Battlefield Maintenance System (BMS) doctrine. Next, training constraints are presented. Third, transmission maintenance task variables are developed and presented along with the data sources from which they were derived. Fourth, the training profile is developed and discussed from the aspect of the demands that transmission maintenance tasks place on training. Last, task and training trade-off issues are developed and presented.

Track Automotive Transmission Repair Mission Description

One of the major tenants of BMS is the merging of what was formerly organizational (ORG) and direct support (DS) levels of maintenance into a single function. This new function, field repair maintenance, will have significant impacts on existing maintenance practices and MOSs. One reason is that maintainer MOSs that were previously performing work at two different maintenance levels (ORG and DS) will now be performing maintenance on equipment at a single maintenance level.

This application of the TIM_{TT} was based on the following assumptions:

1. An increased number of transmission tasks will be performed in locations that are closer to the battlefield.

2. Significant changes will occur in the number and nature of the transmission tasks performed in these forward locations in terms of complexity, skill requirements, performance levels, and tool requirements.

Currently, two MOSs perform transmission maintenance tasks on the M1. They are MOS 63E, M1 Abrams Tank System Mechanic, and MOS 63H, Track Vehicle Repairer. The 63E and 63H also perform maintenance on the M88, as do MOS 63N, M60 Tank System Mechanic and MOS 63T, Bradley Fighting Vehicle System Mechanic.

Figure 4 illustrates the transmission repair mission description which is based on the premise that MOSs 63E, 63H, 63N, and 63T will be merged into one MOS. The resulting MOS will perform field repair level maintenance on all track automotive transmissions.

MISSION PROFILE: TRACK AUTOMOTIVE TRANSMISSION
REPAIRER MISSION PROFILE

1. Performs maintenance on assigned tools and equipment. This consists of preventive maintenance checks and services performed at scheduled intervals as outlined in appropriate technical publications, and shop standing operating procedures (SOPs). The incumbent also performs those unit level (operator and crew) tasks incidental to FR mission requirements.

2. Performs FR maintenance on transmissions, final drives, and related components. Maintenance includes transmission end item repair by component replacement and repair of components. The repairer diagnoses and analyzes component and transmission malfunctions by visual and auditory examination and the use of testing equipment. Isolates faults or malfunctions by systematic elimination of possible causes. Tests, services, adjusts, replaces, and repairs transmission assemblies, subassemblies, and components such as transmission crossdrive center sections, valves, coolers, pumps, motors, linkage, controls, and final drives using authorized tools, test TMDE, and technical publications.

3. Uses tools, shop sets, equipment, and special clothing as prescribed and authorized by TOE, tables of distribution and allowance (TDA), and common tables of allowance (CTA) as well as tool allocation charts and technical manuals.

4. Performs maintenance tasks in accordance with (IAW) procedures and standards prescribed in technical manuals, lubrication orders, technical bulletins, modification work orders (MWOs), and appropriate job aids as listed in 310 series Department of the Army Pamphlets (DA Pams).

5. Performs work in a fixed or semi-fixed maintenance shop, or may also work in maintenance tentage. The transmission repairer is also subject to work in all climatic conditions with variable temperatures. In addition, the repairer may work on-site without shelter. The transmission repairer is exposed to high noise levels, toxic fumes, cleaning solvents, grease, and oils.

6. Lifts and carries heavy weights (50 pounds) over short distances and must be able to perform tasks requiring lifting, pulling, pushing, climbing, and holding objects while lying on back, kneeling, sitting, and standing. During combat, the repairer may be required to work for long periods of time (in excess of 12 hours) and may be exposed to extremely hot or cold ambient temperatures.

7. Performs complete technical inspections (acceptance, initial classification, in process, and final inspections) on transmission system and component repairs. Must understand and apply information contained in technical publications to transmission maintenance requirements. Must be able to test components, subcomponents and transmission end-items for serviceability. Repairer also reviews, prepares and completes maintenance records and maintains a file of technical publications.

8. Supervises lower level transmission repairers; plans and organizes work schedules. Assigns duties and instructs subordinate personnel in proper maintenance practices, procedures, and techniques. Also applies production and quality control procedures to maintenance operations in order to ensure serviceability of transmissions after repair.

Figure 4. Track automotive transmission repairer mission profile.

Training Constraints

Training variables were evaluated in order to develop an outline of how track automotive training is constrained. The constraints on training are summarized in Table 13. The rationale for the constraints are described below.

According to general policy guidance and as a general rule-of-thumb, all training is constrained to current budgetary levels. Therefore, overall training costs should be considered in terms of zero-sum-gain.

For the purposes of this effort, formal resident training is further constrained to 70 hours due to the lack of adequate facilities. All other training requirements must be supported by either OJT or exportable training packages. Training time allotted for these training modes are 80 hours and 5 hours, respectively.

Requirements for aptitude area mechanical maintenance (MM) of the ASVAB are also constrained at the current level of 95. This constraint is based on Headquarters Department of the Army (HQDA) guidance on quality of soldier distribution and recruitment demographics data indicating that the pool of recruits with the required aptitude prerequisites is not large enough to support an increase in MM requirements.

The number of tasks that can be trained during resident training is constrained by budgetary limitations, facility considerations, and training device availability. Table 14 lists the tasks, by number and description, that can be effectively trained with the type and number of training devices available to support training.

A review of the list indicates that none of the major component removal, installation, or replacement tasks can be effectively trained in resident training. The major reason for this finding is at present the training center does not have enough track automotive hulls available to support training of installing, removing, and replacing cross drive transmissions and their component parts. The only training devices available at this time are the transmission components themselves. Therefore, replacement and installation tasks will require training by methods other than resident.

Transmission Maintenance Task Variables

Table 15 is a list of 27 FR maintenance tasks identified as required for sustaining track automotive transmissions in combat. These tasks were derived from analysis of the mission profile and

Table 13

Training Constraints

Requirement	Constraint
ASVAB SCORES	95
LENGTH OF FORMAL TRAINING	70 Hrs.
LENGTH OF OJT	80 Hrs.
EXPORTABLE TRAINING	5 Hrs.
NUMBER OF TASKS	27

Table 14

List of Resident Training Tasks

No.	Task
01	Service Servo Units
02	Replace Servo Units
03	Repair Servo Units
04	Service Coolers, Pumps, and Motors
06	Repair Coolers, Pumps, and Motors
07	Inspect Cross Drive Transmission
08	Service Cross Drive Transmission
10	Adjust Cross Drive Transmission
14	Repair Cross Drive Transmission
18	Adjust Transmission Brake System
20	Repair Transmission Brake System
21	Test Valves
22	Replace Valves
23	Repair Valves
24	Inspect Final Drive
25	Adjust Final Drive
27	Repair Final Drive

Table 15

Transmission Maintenance Sustainment Tasks

No.	Task
01	Service Servo Units
02	Replace Servo Units
03	Repair Servo Units
04	Service Coolers, Pumps, and Motors
05	Replace Coolers, Pumps, and Motors
06	Repair Coolers, Pumps, and Motors
07	Inspect Cross Drive Transmissions
08	Test Cross Drive Transmissions
09	Service Cross Drive Transmission
10	Adjust Cross Drive Transmission
11	Remove Cross Drive Transmission
12	Install Cross Drive Transmission
13	Replace Cross Drive Transmission
14	Repair Cross Drive Transmission
15	Adjust Linkage and Controls
16	Replace Linkage and Controls
17	Repair Linkage and Controls
18	Adjust Transmission Brake System
19	Replace Transmission Brake System
20	Repair Transmission Brake System
21	Test Valves
22	Replace Valves
23	Repair Valves
24	Inspect Final Drive
25	Adjust Final Drive
26	Replace Final Drive
27	Repair Final Drive

data collected from M1 and M88 MACs. The results of the assignment of values for each sustainment task variable are discussed below.

ENABLING CRITERIA. ENABLING CRITERIA for the mission and rules to systematize the assignment of the enabling criteria to tasks were developed by SMEs. SMEs applied the criteria to the transmission sustainment tasks using these rules, resulting in an ENABLING CRITERIA profile.

Figure 5 presents an ENABLING CRITERIA profile for maintaining track automotive transmissions. The figure depicts the ENABLING CRITERIA considered to be required for the sustainment tasks to be performed on transmissions. The height of the bars represents the number of tasks for which the criteria are required to enable performance.

ABILITIES AND SKILLS. An ABILITIES AND SKILLS profile for transmission repair was developed using JAAS. Figure 6 presents this profile, which was based on analysis of the future maintenance job requirements developed from the BMS mission profile.

The JAAS analysis indicates that future maintainers will need to be better educated. The chart shows that requirements in communication skills, conceptual skills, and reasoning skills are high when compared with the other areas. Physical characteristics, perceptual-vision, psychomotor, and gross motor skill requirements are consistent with the abilities needed by all mechanical maintainers.

TASK DIFFICULTY. TASK DIFFICULTY was examined to determine the relative difficulty of learning a task. All tasks were rated on the relative time required to learn the task satisfactorily at skill level 1. The more time required, the higher the level of difficulty.

Figure 7 depicts the relative difficulty of the tasks by the height of the bars on the graph. Repair tasks for #14 (cross drive transmissions), #20 (transmission brake systems), and #27 (final drives), along with #19 (replace transmission break system) provide the greatest challenge in terms of learning difficulty.

TRAINING EMPHASIS. TRAINING EMPHASIS was examined to identify tasks that must be trained during initial MOS training. Tasks were examined based on which tasks the MOS incumbent must learn to perform at skill level 1. Each task was rated on how much emphasis should be placed on training.

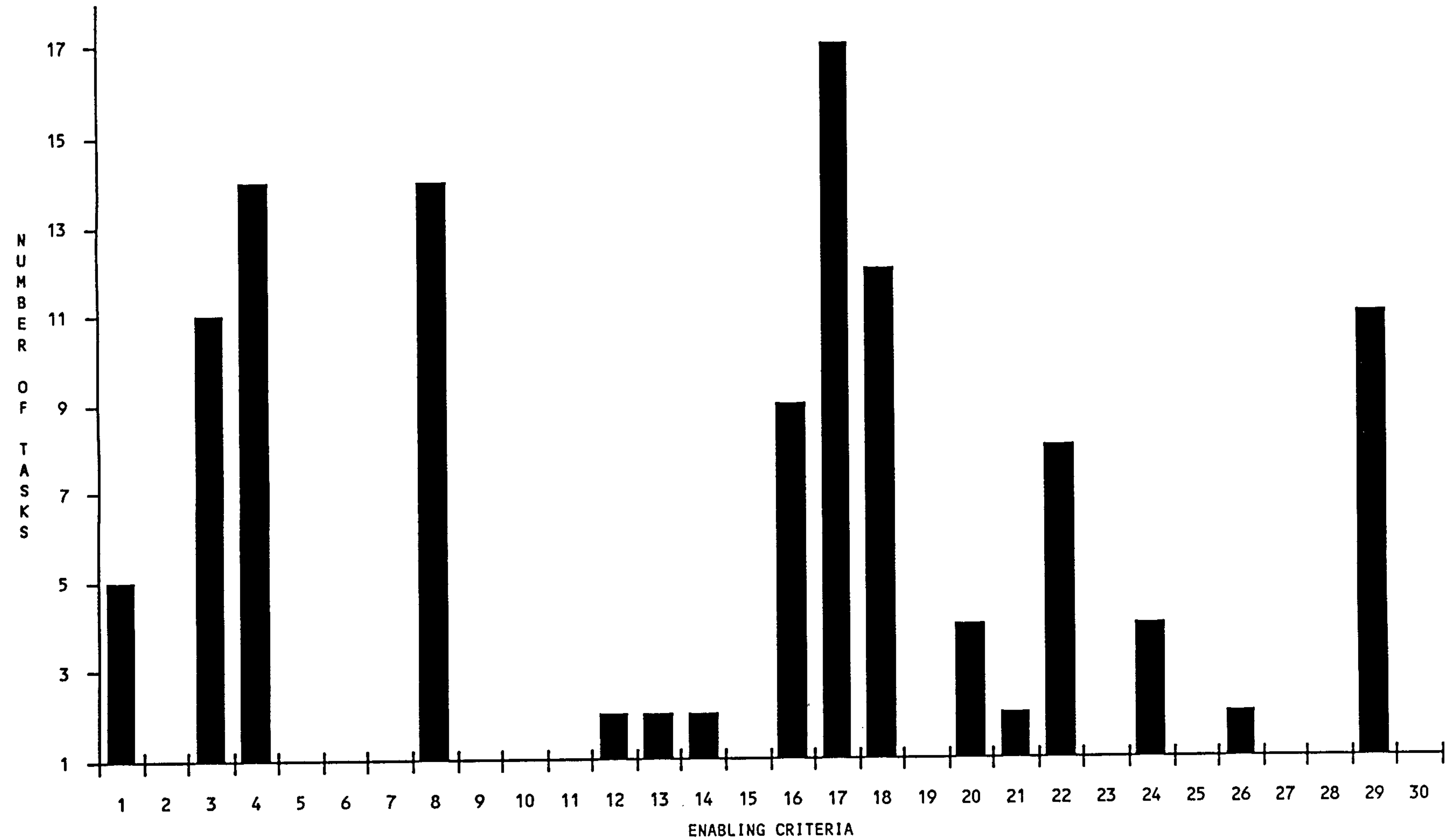

Figure 5. Enabling criteria profile.

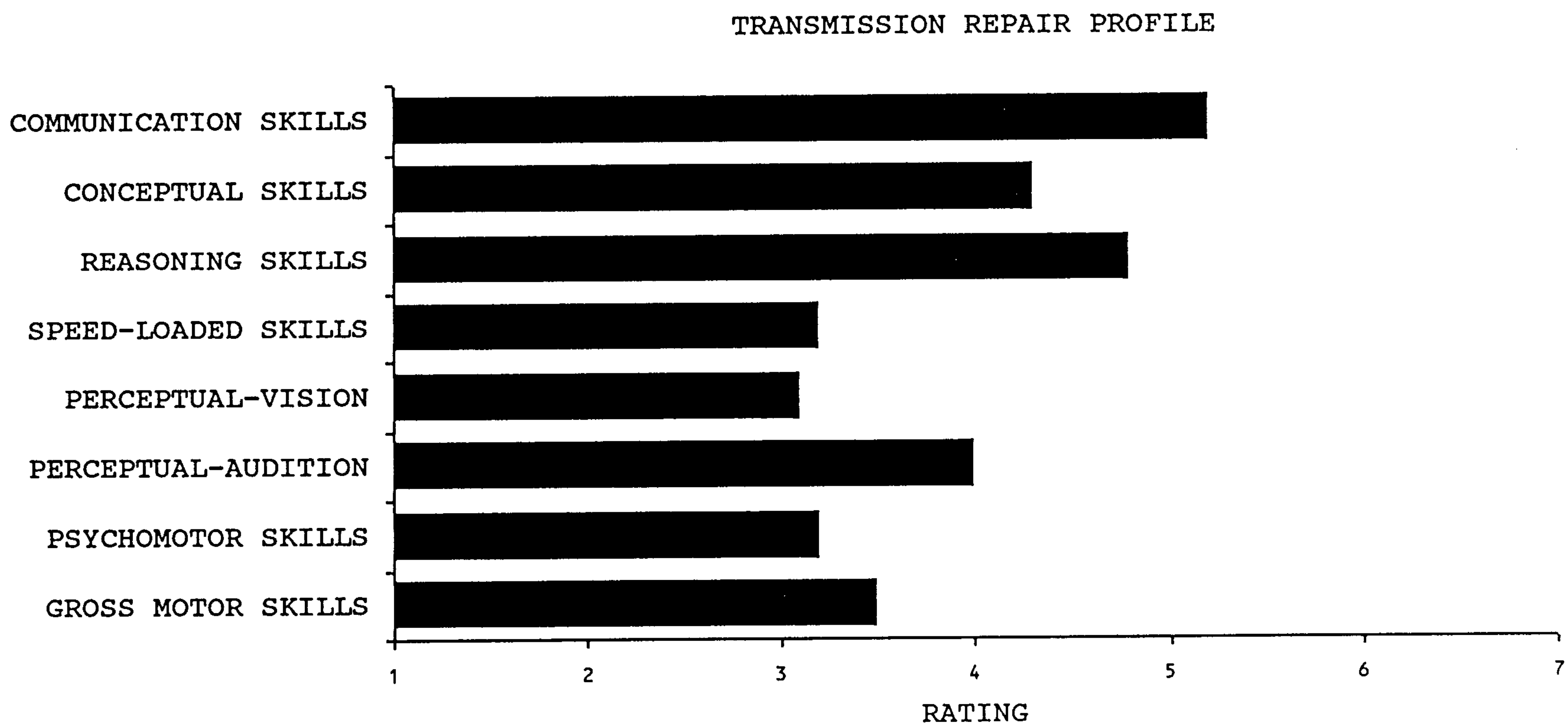

Figure 6. Abilities and skills profile.

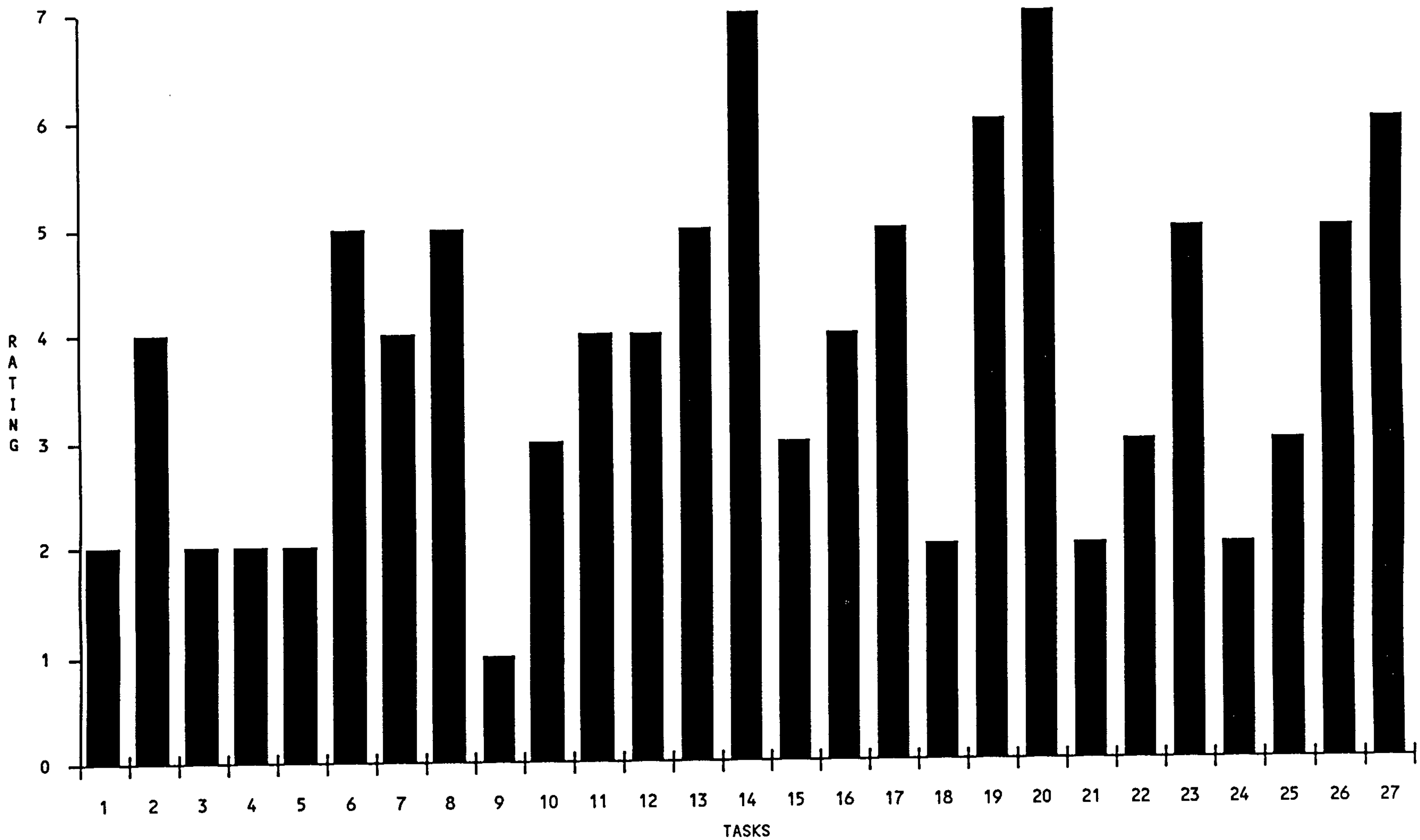

Figure 7. Task difficulty profile.

Figure 8 shows the TRAINING EMPHASIS rating for each task. TRAINING EMPHASIS is measured by the height of the bar on the graph. As indicated, repair tasks for #14 (cross drive transmissions), #20 (transmission brake systems), and #27 (final drives) require the greatest training emphasis.

<u>TASK TIME</u>. Based on SME input, analysis of task difficulty data, and POIs, each task was appraised and estimates made in terms of the time required to perform each task. Table 16 provides a list of the tasks along with the estimated training time required for each. The table indicates that replacement of servo units, replacement and repair of crossdrive transmissions, replacement and repair of transmission brake systems, and replacement and repair of final drives will require a significant training effort.

<u>TOOLS AND TMDE</u>. Table 17 shows the TOOLS AND TMDE required to perform all transmission sustainment tasks at the FR level of maintenance. A review of current Ordnance POIs and the Ordnance Center and School's Table of Distribution and Allowances (TDA) indicate that all tools and TMDE required for transmission training are currently available for use in training.

<u>Mission Task Profile Summary</u>. Table 18 provides the mission task profile for all transmission repair sustainment tasks. The profile represents a summary of the data for each task variable, averaged across all individual tasks. 27 transmission maintenance sustainment tasks require training either by resident, OJT, or exportable training. Both TASK DIFFICULTY and TASK TRAINING EMPHASIS variables averaged four on the seven-point scale. The average mission task training time was six hours.

<u>Mission Training Profile</u>

The mission task list and task profile were examined by SMEs to determine what training is required by the mission tasks. The required training was summarized in a mission training profile, presented in Table 19.

The table shows the maintenance mission requires a minimum ASVAB score of 100 in aptitude are MM. The current requirement for similar tasks is a minimum score of 95 in aptitude area MM.

The length of formal training was determined to be 103 hours. This determination was made based on analysis of current POIs and the mission tasks required by the transmission repair scenario.

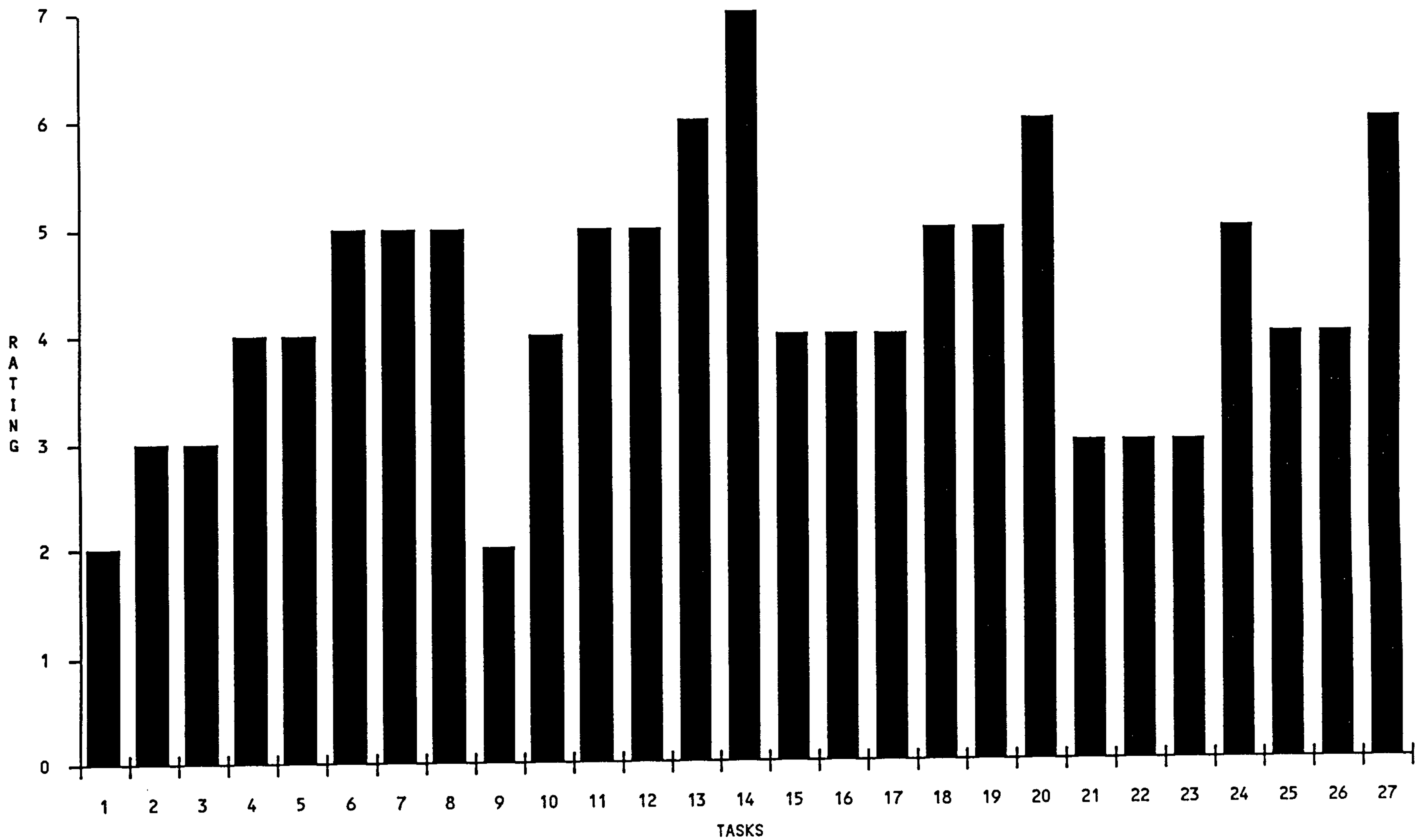

Figure 8. Training emphasis profile.

Table 16

Transmission Sustainment Tasks and Estimated Training Time

No.	Task	Task Time (hours)
01	Service Servo Units	.30
02	Replace Servo Units	9.10
03	Repair Servo Units	2.50
04	Service Coolers, Pumps, and Motors	1.50
05	Replace Coolers, Pumps, and Motors	1.30
06	Repair Coolers, Pumps, and Motors	5.40
07	Inspect Cross Drive Transmissions	.30
08	Test Cross Drive Transmissions	.30
09	Service Cross Drive Transmission	1.30
10	Adjust Cross Drive Transmission	3.50
11	Remove Cross Drive Transmission	5.40
12	Install Cross Drive Transmission	5.40
13	Replace Cross Drive Transmission	18.00
14	Repair Cross Drive Transmission	50.00
15	Adjust Linkage and Controls	.30
16	Replace Linkage and Controls	.30
17	Repair Linkage and Controls	1.50
18	Adjust transmission Brake System	1.00
19	Replace Transmission Brake System	23.30
20	Repair Transmission Brake System	13.30
21	Test Valves	.50
22	Replace Valves	1.50
23	Repair Valves	4.00
24	Inspect Final Drive	1.00
25	Adjust Final Drive	.50
26	Replace Final Drive	8.00
27	Repair Final Drive	7.50
	Total	167.00
	Average	6.20

Table 17

Task and Tools Inventory

No.	Task	Tools T1	T2	T3	T4	T5
01	Service Servo Units	02	05			
02	Replace Servo Units	02	03	05		
03	Repair Servo Units	02	03	05	11	12
04	Service Coolers, Pumps, and Motors	02				
05	Replace Coolers, Pumps, and Motors	02	03	05	11	
06	Repair Coolers, Pumps, and Motors	02	03	11	12	
07	Inspect Cross Drive Transmissions	02				
08	Test Cross Drive Transmissions	02	03	05	12	
09	Service Cross Drive Transmission	02				
10	Adjust Cross Drive Transmission	02				
11	Remove Cross Drive Transmission	02	03	05		
12	Install Cross Drive Transmission	02	03	05		
13	Replace Cross Drive Transmission	02	03	05		
14	Repair Cross Drive Transmission	02	03	05	11	12
15	Adjust Linkage and Controls	02				
16	Replace Linkage and Controls	02	03	05		
17	Repair Linkage and Controls	02	03	05	11	12
18	Adjust Transmission Brake System	02				
19	Replace Transmission Brake System	02	03	05		
20	Repair Transmission Brake System	02	03	05	11	
21	Test Valves	02	03	12		
22	Replace Valves	02	03	05		
23	Repair Valves	02	03	05	11	12
24	Inspect Final Drive	02				
25	Adjust Final Drive	02				
26	Replace Final Drive	02	03	05		
27	Repair Final Drive	02	03	05		

Tools and Test, Measurement and Diagnostic Equipment

TOOLS

No.	Description
02	Tool Set, Transmission Special Field Repair
03	Tool Set, Field Repair
05	Tool Set, General Mechanics
11	Tool Set, Shop Equipment, Automotive Repair

Test, Measurement and Diagnostic Equipment

No.	Description
12	Analyzer Set, Transmission (STE M1 and M2)

Table 18

Mission Task Profile

Minimum Aptitude Area (MM) Score:		100 Points
Average Task Difficulty Rating:		4
Average Task Emphasis Rating:		4
Average Task Training Time:		6.20 Hrs.
Tools:	02	Tool Set, Transmission, Special, Field Repair
	03	Tool Set, Field Repair
	05	Tool Set, General Mechanics
	11	Tool Set, Shop Equipment, Automotive Repair
TMDE:	12	Analyzer Set, Transmission (STE M1 and M2)

Table 19

Mission Training Profile

Variable	Training Requirement
ASVAB SCORE	100
LENGTH OF FORMAL TRAINING	103 Hrs.
LENGTH OF OJT	66 Hrs.
LENGTH OF EXPORTABLE TRAINING	5 Hrs.
NUMBER OF TASKS TO BE TRAINED	27

The length of OJT was estimated to be 66 hours. However, no hours were recommended for exportable training as none of the SMEs felt that this mode of training was effective. Also reflected in the table is the number of transmission sustainment tasks judged by the panel as requiring training. The panel felt that all 27 of the sustainment tasks should be trained if the maintainer is to be able to perform effective transmission repair.

Trade-Off Identification

The training trade-off issues were identified by comparing the training constraints with the training requirements. Table 20 shows this comparison and the differences between the requirements and constraints.

Two issues can be identified as needing attention. First, the ASVAB score for aptitude area MM exceeded the constraint on ASVAB scores. Second, a disparity of 33 hours was found between the training requirement and the constraint on training.

The table also shows requirements for two training variables that were below the constraints. First, the time allotted by the SMEs for OJT training fell short of the time available. Second, no exportable training was recommended although five hours was available in the budget. Although OJT and exportable training were below the constraints, the total training hours requirement exceeded the sum of the training constraints by 14 hours.

Mission-Relevant Trade-offs. All five training variables were reviewed and rated according to their importance to the overall transmission repair mission. Priority ratings indicated the order in which future trade-offs must be performed so that high priority trade-offs constrain lower priority trade-offs, rather than the opposite. The following is a list of the variables in order of highest to lowest priority:

1. Length of formal training

2. ASVAB score

3. Length of OJT

4. Length of exportable training

5. Number of tasks

Table 20

Trade-Off Issue Identification

Variable	Training Constraint	Training Requirement	Difference
ASVAB SCORES	95	100	+5
LENGTH OF FORMAL TRAINING	70 Hrs.	103 Hrs.	+33 Hrs.
LENGTH OF OJT	80 Hrs.	66 Hrs.	-14 Hrs.
EXPORTABLE TRAINING	5 Hrs.	0 Hrs.	-5 Hrs.
NUMBER OF TASKS	27	27	0

Although some variables either matched or were less than the constraints, all variables were rated. The reason for this is once trade-offs are performed, the significance of any variable as a candidate for trade-offs may change because the variables are interdependent. When values of one variable are changed to meet the constraints, others may change. Therefore, analysis prior to actually performing trade-offs is required of all variables, whether they meet the constraints or not, in order to derive an indication of the importance of the variable in relation to the others.

Trade-off Issues and Possible Solutions. Table 21 lists the trade-off issues and possible solutions for addressing each. The table shows that the ASVAB requirement in aptitude area MM may be traded-off or reduced by (1) increasing the length of formal training, OJT, or exportable training, or (2) by decreasing the number of tasks to be trained, enabling criteria, abilities and skills, or task difficulty (this could be potentially achieved by considering different merger possibilities, i.e., restructuring options - e.g., an alternative to merging 63E, 63H, 63N, and 63T into one MOS might be the formation of two MOSs, one consisting of 63E and 63H, and the other consisting of 63N and 63T) or (3) a combination of some or all of these potential corrective actions. This same process can be used for determining the trade-offs necessary to address length of formal training, OJT, and exportable training.

Table 21

Trade-Off Issues and Possible Solutions

Issue	Corrective Action
	Training versus Training
Length of formal training exceeds constraint	1. Decrease number of tasks 2. Increase OJT 3. Increase exportable training 4. Increase abilities and skills
	Tasks versus Training
	1. Decrease enabling criteria 2. Decrease number of tasks 3. Decrease task difficulty 4. Decrease task emphasis
	Training versus Training
ASVAB score required exceeds constraint	1. Increase length of formal training 2. Increase length of OJT 3. Increase length of exportable training 4. Decrease number of tasks
	Tasks versus Training
	1. Decrease abilities and skills 2. Decrease enabling criteria 3. Decrease number of tasks 4. Decrease task difficulty

Acronyms

ASVAB	Armed Services Vocational Aptitude Battery
BMS	Battlefield Maintenance System
CO	Combat
DS	Direct Support
ECA	Early Comparability Analysis
EL	Electronics
FMs	Field Manuals
FR	Field Repair
HQDA	Headquarters Department of the Army
JAAS	Job Abilities Assessment System
MIST	Man-Integrated Systems Technology
MM	Mechanical Maintenance
MOCS	Military Occupational Classification Structure
MOS	Military Occupational Specialty
MPT	Manpower, Personnel, and Training
O&O	Operational and Organizational
ORG	Organizational
P-CON	Personnel Constraints
SAT	Systems Approach to Training
SC	Surveillance and Communications
SMEs	Subject Matter Experts
T-CON	Training Constraints
TDA	Table of Distribution and Allowances
TIM_{TT}	Task and Training Trade-off Identification Model
TMDE	Tools and Test, Measurement, and Diagnostic Equipment
TMs	Technical Manuals
TOEs	Tables of Organization and Equipment

References

Akman, A. and Haught, D. (1990). Review and analysis of the military occupational speciality (MOS) restructuring problem. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0002, Research Note.

Haught, D. and Enwright, J. (1990). Battlefield maintenance case study: Task commonality analysis for system maintenance requirements. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0003, Research Product.

Headquarters, Department of the Army. Enlisted Career Management Fields and Military Occupational Specialties. Army Regulation 611-201. Washington, D.C.: Headquarters, Department of the Army. 1989.

Headquarters, Department of the Army. Guide for Preparation of Changes to the Military Occupational Classification Structure (MOCS). Washington, D.C.: Headquarters, Department of the Army, 1988.

Herlihy, D.H., Iceton, J.A., Oneal, J., and Guptill, R.V. (1985). Man integrated systems technology (User's Guide). Wilimington, MA: Dynamics Research Corporation.

Kaplan, J. and Hartel, C. MANPRINT methods: Development of HARDMAN III. Alexandria, VA: U.S. Army Research Institute.

Muckler, F.A., Seven, S.A., and Akman, A. (1990). Proposed method for military intelligence job ability assessment. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0001, Research Note.

Steinbach, C., Akman, A., and Haught, D. (1990). Military occupational specialty (MOS) restructuring research and development blueprint. Silver Spring, MD: Akman Associates, Inc., Contract DAHC35-89-D-0028 0003.

WORKING PAPER 89-202

39L AND 39Y MERGER ACTION:

INPUTS TO DEVELOPMENT OF A TRAINING STRATEGY

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39L AND 39Y MERGER ACTION: INPUTS TO DEVELOPMENT OF A TRAINING STRATEGY

Contents

39L AND 39Y MERGER ACTION: INPUTS TO DEVELOPMENT OF A TRAINING STRATEGY

Introduction

The Office of the Chief of Signal (OCOS) at the U.S. Army Signal Center and Fort Gordon is considering the merger of two Military Occupational Specialties (MOSs): 39L Field Artillery Digital Systems Repairer and 39Y Field Artillery Tactical Fire Direction Systems (TACFIRE) Repairer. It is possible that after the merger, the merged MOS will become an Additional Skill Identifier (ASI) position under the 29J MOS Teletypewriter Equipment Repairer. The reasons for considering these mergers are: (1) the number of personnel in 39L and 39Y needed to support the TACFIRE equipment are few in number; currently, there are approximately 100 soldiers in each MOS; (2) because of the small MOS populations there are few promotion opportunities and soldiers are attriting from the 39L and 39Y MOSs faster than they are entering; and (3) as a consequence, adequate maintenance support for TACFIRE is seriously endangered. Merging the 39L and 39Y MOSs and then joining them with the 29J (there are approximately 2000 soldiers in this MOS) will open up much greater opportunities for promotion and make the TACFIRE jobs much more attractive. The 29J MOS is a candidate MOS because its soldiers are becoming responsible for repair of new equipments which are comparable to those currently maintained by the 39L and 39Y MOSs.

When MOSs are merged, the new MOS is often responsible for a larger set of equipments and, hence, performance of more tasks. Questions must be asked as to whether the merger will have impacts on MOS aptitude requirements, training costs, training strategies, and sustainment training requirements. This paper reports on interviews held with 39L and 39Y personnel to gather their opinions regarding these issues and to gather data useful as inputs to the development of the appropriate training strategy. The paper will present the methods used to obtain the opinions and data, the findings, and recommendations.

Method

Interviews were conducted at Fort Stewart, Georgia on 23-24 March 1989. Interviews of the 39L and 39Y personnel were structured to obtain answers to the questionnaires in Appendix A and to allow open discussion of issues of concern to the soldiers. These interviews were conducted in a group setting, and group consensus was reached on each questionnaire item and issue of concern. Subsequently, a discussion was held with their Warrant Officer Section Chief regarding the merger action and the findings.

The group interviewed was comprised of three 39Ls and three 39Ys from the 632d Maintenance Company. One 39L was being cross trained in 39Y tasks and a 39Y had the 39L as a secondary MOS. The ranks of the interviewed subject matter experts (SMEs) were as follows:

39L: PV2, SPC, and SGT
39Y: SPC, SPC(P), and SGT

The questionnaires appear in Appendix A. They were administered in the order in which they appear below. The purposes of each questionnaire are:

Equipment Lists: Three lists were developed: one for tools and equipments common to the 39L and 39Y, one for the 39L, and one for the 39Y. These lists were derived from the programs of instruction (POI) for the MOSs and from the Army Manpower Requirements Criteria (MARC) Maintenance Data Base. Because some of the subsequent questionnaires are answered with respect to each individual item of equipment, the first question asked was whether or not the equipment lists were correct. Changes were made to these original equipment lists based on SME input. The original lists are presented in Appendix A. The final set of equipments per MOS appear in Appendix B.

Questions for Individuals: As the title suggests, it had been expected that this questionnaire would be presented on a one-on-one basis. As noted above, these questions were actually asked in a group setting and group consensus was reached on each item. One form was completed for each MOS. The questions concern the appropriateness of the training received, and the impact of increasing the number of equipment items maintained and tasks performed due to the merger of the two MOSs.

Equipment Questions for Individuals: Again, as noted above, these questions were actually asked in a group setting, contrary to the original intent, and group consensus was reached on each item. One form was filled out for each item of equipment from the revised 39L and 39Y equipment lists. The purpose of the form was to gain information on the type and relative difficulty of repair actions performed, and the relative need for sustainment training.

39L vs. 39Y Commonalities vs. Differences in Equipments and Tasks: This questionnaire was planned for group administration. The purpose of this questionnaire was to gain information regarding the commonalities and the differences between the equipments that the 39L vs. 39Y work on and the nature of what they do to the equipments. The questions addressed each possible combination of one item from the 39L list of equipments vs. items from the 39Y list. It was hoped that, if there is a possibility of generic training and reduced course length (as opposed to simply adding up current blocks of instruction), then the data from these questionnaires would indicate the extent to which generic training could occur and would provide useful insights regarding how to proceed with course development for the merged MOS.

Group Questions for Personnel in MOS 39L and 39Y: This questionnaire was also planned for group administration. This questionnaire contained the same impact questions asked in the Questions for Individuals questionnaire described above. It was administered as the final questionnaire to see if the SME responses agreed with their initial responses and to determine if, after having made judgments on all the individual equipment items and seen the magnitude of their jobs, opinions would change.

Findings

The findings are presented in following order: (1) Issues of concern to the soldiers and (2) Questionnaire responses. The questionnaire responses are presented in the order in which they appear in the Method section.

Issues of Concern

Reenlistment

The soldiers stated that the Army ceased giving reenlistment bonuses to 39Ls and 39Ys in 1987. Further, the SMEs' reenlistment counselors encouraged them to change to combat MOSs (e.g., forward observers, howitzer crewmen, paratroopers) instead of reenlisting as 39Ls and 39Ys. The soldiers stated that, in their opinion, the foregoing indicated that the Army had no interest in and did not value their technical capabilities. This, in combination with the lack of promotions, discouraged them and some indicated that they did not plan to reenlist. They saw civilian industry as not only paying them better, but also enabling them to do technical work which they enjoyed (as opposed to combat positions, in which they had no interest).

Promotion

The lack of promotions in their MOSs, as noted above, discouraged these soldiers. They were very happy to hear that the OCOS was concerned about this and that creating promotion potential was one reason for consideration of the MOS merger actions.

29J Merger

The 39L and 39Y soldiers, while very supportive of a 39L and 39Y merger, did not like the idea of merging with the 29J as an ASI. They felt that there was no relationship between what they do versus what the 29Js do and that the frequency of 29J equipment failures would reduce their capability to maintain their own equipments. It should be noted, however, that: (1) they had no knowledge of the new equipments, with advanced technologies, being assigned to the 29J and (2) there are no current plans to reduce manpower in any of the MOSs.

Manpower

The soldiers cautioned against any thoughts that, because each soldier could do the jobs of three MOSs under the merged condition, any reductions could be made in manpower - the number of bodies assigned to a maintenance shop. They said that they work hard and are often fatigued already. They said that fatigue has at least two effects: (1) greater likelihood of serious accidents in working with the electronic components; and (2)

longer repair times due to the tendency to do single track diagnosis and, hence, inability to identify the correct solution.

Tool Kits and Parts

The 39L and 39Y MOS personnel are authorized to perform Direct Support (DS) maintenance, not General Support (GS). These soldiers contended, however, that they do both DS and GS to the fullest extent possible. Apparently, in their previous assignments, if equipment could not be fixed locally then it was sent directly to Depot rather than to a GS shop, often never to return. They indicated that their major difficulty in doing GS maintenance was the lack of available parts and proper tools. (It should be noted that this reported lack of parts and tools was probably due to the fact that they are not authorized by the maintenance allocation chart (MAC) to have GS tools.)

Questions for Individuals

Basic Electronics Training Both the 39Ls and the 39Ys felt that their courses were much too short in length and would have been improved with expanded content. The only exception was that the 39Ys felt that there was too much computer theory presented in their course.

Equipment Specific Training Again, both the 39Ls and the 39Ys felt that their courses were much too short in length and would have been improved with expanded content. Further, they felt that even though the 39L required less training, on the job training (OJT) for the 39L tasks was not feasible. They did indicate, however, that the four week equipment specific training course currently given 39L trainees could possibly be shortened to two to three weeks for personnel already experienced in unit performance of 39Y tasks.

To What Level of Equipment Assembly Were You Trained to Perform Maintenance? The 39Ls indicated that they were trained to do DS maintenance at the end item and assembly levels and to replace cards. The 39Ys, on the other hand, indicated that they were trained down to the discrete component level.

To What Level of Equipment Assembly Do You Actually Perform Maintenance Actions on the Job? The 39Ls indicated that they actually do GS maintenance and go to the subassembly level. The 39Ys indicated that they perform at the same level for which they were trained, the discrete component level.

Merger Impacts - Is the Introduction of More Equipments and Associated Tasks into Your MOS Likely to:

Create a Sustainment Training Problem? None of the soldiers for either MOS saw this as a potential problem.

Create a Need for More Aptitudes or Higher Levels of Aptitude? No one saw this as likely to happen.

Create a More Interesting Job Overall Due to the Variety of Tasks? The immediately unanimous response to this was a strongly positive "yes".

Result in Being Able to Keep Your Equipment Operationally Available (Ao) for a Greater Percentage of the Time? Again, the answer was a strongly positive "yes". They felt that turnaround time on repairs would be quicker, in general, due to having more personnel skilled in performance of the same, and larger set, of tasks. This was because: (1) Diagnosis often proceeds much more quickly when two soldiers, with differing mind sets, can work the problem; and (2) A surge of repair actions on one particular equipment component could be dealt with more expeditiously.

Equipment Questions for Individuals

Figure 1 presents a summary of the data from this questionnaire. The detailed data tabulations, listing the equipment items per response, are presented in Appendix B. The summary is presented in three sections: difficulty of repair actions, training, and frequency and duration of repairs. Each grouping of data, by question, presents the number of equipment items for which responses were provided and the percentages of those equipment items per each rating.

Difficulty of Repair Actions

It is immediately obvious, in reviewing the percentages per difficulty rating and comparing the percentages for the two MOSs, that the overall job of the 39Y is considered more difficult. For example, for the 39Y only 21% of the equipment items were judged as easy to diagnose while 29% were judged as difficult to diagnose. In contrast, for the 39L, 80% of the equipment items were judged easy to diagnose and the remaining 20% were judged to be somewhat easy.

Judgments of task difficulty were made for three types of maintenance actions: remove and replace, fault diagnosis, and repair. Of the three, fault diagnosis was judged overall to be the most difficult. In most cases, once the fault had been diagnosed, repair was judged to be relatively easy. Most of the remove and replace tasks were judged to be relatively easy if enough soldiers were available to perform the action. Weight and accessibility were the primary considerations on most equipment items.

Training

Responses to "Difficulty of Skill Acquisition" indicate that learning the skills needed to maintain each of the equipment items was judged to be more difficult for the 39Y. 100% of the equipment maintenance skills for the 39L were judged easy to

learn, in contrast with only 44% of those for the 39Y. 26% of the equipment maintenance skills for the 39Y were judged as difficult to learn.

Given the relative difficulty of the job and of acquiring the skills for the 39Ys, it is perhaps not surprising that the 39Y felt the need for sustainment training on more equipments than did the 39L. Where sustainment training was felt to be needed, the soldiers indicated that refresher training every quarter was necessary in most cases.

Frequency and Duration of Repairs

The 39Ls saw each of their equipment items at least once every two months on the average. The 39Ys, on the hand, saw most of their equipment items less frequently. The 39Ys generally required from one to four hours to complete their repairs. This is, of course, under perfect conditions - parts available and no interruptions. Some 39Y items took considerably longer to repair on occasion. The reason for this was intermittent failures; i.e., the equipment items would not fail every time, rather they would begin operating normally for a while before the fault could be diagnosed. It is unknown the extent to which the reported fact that the soldiers were doing GS level maintenance in addition to DS affected the judgments of duration.

39L vs. 39Y Commonalities vs. Differences

The intent had been to complete one questionnaire per 39L vs. 39Y equipment item combination. No questionnaires were completed. The reason is that the soldiers felt that there were no commonalities between their equipments other that the basic electronic rules under which they operated. This is a frequently encountered perception when attempting to compare equipments. Whether or not it is true in this case cannot be determined from this investigation.

Group Questions for Personnel in 39L and 39Y

The responses given to this questionnaire at the end of the day were completely consistent with those given at the beginning of the day; to wit, the merging of the 39L and 39Y MOSs would: not create a sustainment training problem, not create a need for more aptitudes or greater levels of aptitude, and would create a more interesting job overall. They felt the merger would result in being able to keep the equipment operationally available a greater percentage of the time.

Recommendations

Training

A concern in MOS merger actions is the training strategy in terms of (1) duration of acquisition training for new trainees and (2) how to train current MOS personnel in the additional new skills. With respect to the first item, there were no data collected in this investigation to suggest the possibility of reducing training time for new trainees (i.e., that the duration be something less than the summation of blocks of instruction). Rather, the possibility of increased training time was suggested by: the judgments of the soldiers that training time and content should be increased; their opinions that there were no commonalities between their equipment items; and their discussions to the effect that, in their previous units at least, they do perform GS maintenance. It is therefore recommended that any decisions to shorten training times for new trainees be made with considerable caution.

With respect to the second item, additional training of current MOS personnel in the new skills, a more optimistic recommendation can be made. The soldiers shared the opinion that experienced 39Y personnel should be able to learn 39L tasks in less than the usual six weeks of equipment specific training. It can be conjectured that this may be for one or both of two reasons: (1) There are indeed some commonalities between the equipments or (2) The unit experience teaches them some things about the 39L tasks so there is less to learn. In any event, it is recommended that a course of approximately four weeks duration for training the 39Y in 39L skills be developed, implemented, and evaluated.

No opinions were obtained on the duration of training needed by experienced 39L personnel to learn 39Y skills. If either reasons (1) or (2) presented in the paragraph above should hold true then it would be expected that the training may well be shortened from the twelve weeks needed for initial trainees. It is recommended that this be examined further.

Expedite Merger Actions

It was made clear to all persons with whom the merger action was discussed that the OCOS is working to accomplish the 39L and 39Y merger action as quickly as possible. It was suggested by the Warrant Officer that the costs of delaying the merger action be documented if feasible and useful for supporting faster merger action.

APPENDIX A

EQUIPMENT LISTS AND QUESTIONNAIRES

MOS 39L AND 39Y TOOLS AND EQUIPMENTS

COMMON LIST

xa. Multimeter

xb. Potentiometers

xc. Rheostats

xd. DC Voltmeter

xe. DC Ammeter

xf. Ohmmeter

xg. Motors and Generators

xh. Oscilloscopes

xi. Transformers

xj. Oscillators

xk. Remote Control Group AN/GRA-39

xl. 12 Series Radio Sets

xm. AN/GRC-160 Tactical FM Radio Sets

MOS 39L LIST OF EQUIPMENTS

POI DERIVED

1a. AN/PSQ-2A Digital Message Device (DMD)

1b. AN/PSQ-4 DMD

1c. AN/PSQ-5 DMD

1d. Battery Computer System (BCS) for Fire Direction Systems (FDS) of MLRS and Lance

1d.1 BCS Operations and BITE

1d.2 BCS Power Distribution Unit

1d.3 BCS Gun Display Unit

1d.4 BCS Battery Computer Unit

1d.5 BCS Communications

1d.6 BCS Diagnostic Program

1e. Mortar Ballistic Computer MBC-23

1f. Meterorological Data Processing Group (MDPG) OL-192 Diagnostic Program

1g. Tactical Radio

OTHER DERIVED (from MARC Maintenance Data Base)

1h. Carrier Personnel Full Tracked: Armored Fir...

1j. Computer Group Gun Direction: OL-200/GYK-29

1k. Data Display Arty Battery: AN/GSQ-122

1m. Computer Gun Direction

1n. Imagery Interpretation System: AN/TYG-11(V)

1p. Meteorological Data System: AN/TMG-31

1q. Message Device Platoon Leader Digital: (MLR...

1r. Monitor Television: GLLD

1s. Maintenance Facility Electronic Equipment: ...

1t. FIST-V on M113A3

1u. CBT Lasing & FIST Vehicle (FSCOLS)

1v. Reproducer Signal Data

1w. Tactical Imagery Interpretation Facility: A...

1x. Test Set Computer Logic Unit

1y. Rangefinder Laser AN/PVS-6

1t. FIST-V on M113A3

1u. CBT Lasing & FIST Vehicle (FSCOLS)

1v. Reproducer Signal Data

1w. Tactical Imagery Interpretation Facility: A...

1x. Test Set Computer Logic Unit

1y. Rangefinder Laser AN/PVS-6

39Y LIST OF EQUIPMENTS

POI DERIVED
TACFIRE

2a. Cables

2b. Operating System

2c. Power Converter Group

2d. AN/GYK-12 Computer

- 2d1. Central Processing Unit (CPU)
- 2d2. Mass Core Memory Unit (MCMU)
- 2d3. I/O Unit
- 2d4. CPU Special Registers
- 2d5. TACFIRE Programs
- 2d6. OS Executive Kernal

2e. Module Test Set (MTS)

- 2e1. Passive Maintenance Device

2f. CPU (skip - done under 2d1)

- 2f1. Data Bus
- 2f2. Program Level Controller
- 2f3. Instructor Controller
- 2f4. Memory Interface Controller
- 2f5. Mass Core Memory Unit (MCMU) - done under 2d2. Any reason to do it again?
- 2f6. IOU - done under 2d3. Any reason to do it again?
- 2f7. Magnetic Tape Unit
- 2f8. Electronic Line Printer (or, should this be 2g?)
- 2f9. Artillery Control Console (or, should this be 2h?)

2i. Switch Panel Assembly

2k. Display Editor

2m. Alphanumeric Keyboard

2n. Digital Display Terminal

2p. Communications Terminal Box

2q. Communications Junction Box

2r. Communications Control Unit

2s. Remote Control Monitoring Unit

2t. TACFIRE Communications Interface

2u. Variable Format Message Entry Device

2v. Digital Plotter Map

2w. Electronic Tactical Display

2x. TACFIRE System

2y. Tactical Radio System

<u>OTHER DERIVED (from MARC Maintenance Data Base)</u>

2aa. Fire Direction Center Artillery: OA-8390/GS

2bb. Fire Direction Center Artillery: OA-8390 B/

2cc. Fire Direction Center Artillery: OA-8389/GS

2dd. Message Device Digital: AN/PSG-2

2ee. Sound Ranging Set: AN/TNS-10 Less Power

QUESTIONS FOR INDIVIDUALS IN MOS _______

1. Is the overall equipment list for MOS _______ correct?
   Yes____ No ____

   If "No", what should be added or deleted?

2. Is the list broken down to the right level to describe your activities? Yes____ No____

   If the answer is "No", please help us to restructure.

3. Your instruction at Fort Sill for this MOS consisted of a Basic Electronics section, first, and then an equipment specific section.

   <u>For the Basic Electronics section</u>:

   Was the content of the course:

1	2	3	4	5
much more than needed		just what was needed		not nearly enough

   Was the duration of the course:

1	2	3	4	5
much too long		about right		much too short

   Would you recommend any changes? If so, what?

For the Equipment Specific section:

Was the content of the course:

1	2	3	4	5
much more than needed		just what was needed		not nearly enough

Was the duration of the course:

1	2	3	4	5
much too long		just right		much too short

To what level of equipment assembly were you trained to perform maintenance?

system_____ end items_____ assemblies_____ subassemblies____
PC boards_____ modules_____ digital components_____
discrete components_____

To what level of equipment assembly do you actually perform maintenance actions on the job?

system_____ end items_____ assemblies_____ subassemblies____
PC boards_____ modules_____ digital components_____
discrete components_____

Would you recommend any changes? If so, what?

4. Is introduction of more equipments and associated tasks into your MOS likely to:

a. Create a sustainment training problem?
Yes_____ No_____

If "Yes", please explain:

b. Create a need for more aptitudes or higher levels of aptitude? Yes_____ No_____

If "Yes", please explain:

c. Create a more interesting job overall due to the variety of tasks? Yes_____ No_____

d. Result in being able to keep your equipment operationally available (Ao) for a greater percentage of the time?
Yes_____ No_____

If "No", please explain:

e. Any other problems or benefits? Yes_____ No_____

If "Yes", please explain:

EQUIPMENT QUESTIONS FOR INDIVIDUALS IN MOS _______

4. Per equipment item ____,
please answer the following questions:

a. Difficulty of remove and replace actions:

1	2	3	4	5
Easy		Moderate		Difficult

b. If performed, difficulty of fault diagnosis:

1	2	3	4	5

c. If performed, difficulty of repair actions:

1	2	3	4	5

d. Difficulty of skill acquisition:

1	2	3	4	5

e. Frequency of refresher training needed if not performed frequently on the job:

1	2	3	4	5
weekly	monthly	quarterly	biannually	annually

g. What is the frequency and duration of repairs?

Frequency per year ______________________________________

Duration (hrs, mins) ______________________________________

h. Is repair necessary for operational availability (Ao)?

Yes______ No______

39L VS. 39Y COMMONALITIES VS. DIFFERENCES

EQUIPMENTS AND TASKS

MATRIX CELL ___________ : ____
____

1. TECHNOLOGY:

a. Electrical functioning:
Commonalities:

Differences:

b. Electronic functioning:
Commonalities:

Differences:

c. Mechanical functioning:
Commonalities:

Differences:

d. Electro-mechanical functioning:
Commonalities:

Differences:

e. Computer design:
Commonalities:

Differences:

f. Computer functioning:
Commonalities:

Differences:

g. Tools used and manner of use:
Commonalities:

Differences:

2. TASKS:

a. Remove and replace actions, and knowledges required:
Commonalities:

Differences:

b. If performed - diagnostic strategies, and knowledges required:

Commonalities:

Differences:

c. If performed - repair actions, and knowledges required:

Commonalities:

Differences:

d. Complexities and difficulty of performing maintenance tasks:

Commonalities:

Differences:

e. Any input/output relationships? Yes_____ No_____

If "Yes", what are they?

f. Any 39L <----> 39Y job interactions or interrelationships? Yes_____ No_____

If "Yes", please describe:

g. Relationships to 29J?

h. Relationships to 39T?

GROUP QUESTIONS FOR

PERSONNEL IN MOS 39L AND 39Y

Is the merging of MOS 39L and MOS 39Y likely to:

a. Create a sustainment training problem?
Yes_____ No_____

Please explain your answer:

b. Create a need for more aptitudes per person or higher levels of aptitude? Yes_____ No_____

Please explain your answer:

c. Create a more interesting job overall due to the variety of tasks? Yes_____ No_____

d. Result in being able to keep the equipment operationally available (Ao) for a greater percentage of the time?
Yes_____ No_____

If "Yes", try to give an estimate of the improvement in whatever terms you can:

If "No", please explain:

e. Any other problems or benefits? Yes_____ No_____

If "Yes", please explain:

APPENDIX B

EQUIPMENT QUESTIONS FOR INDIVIDUALS: DETAILED DATA TABULATION

39Y TASK PER EQUIPMENT ITEM JUDGMENTS

DIFFICULTY OF REMOVE AND REPLACE ACTIONS

Don't Do
- 2t TACFIRE Communications Interface

Rarely Do
- 2p Communications Terminal Box
- 2q Communications Junction Box

Easy (1)
- 2y Power Function Box
- 2v1 Digital Control Unit
- 2u Remote Data Terminal
- 2s Remote Control Monitoring Unit
- 2r Communications Control Unit
- 2n Digital Data Terminal (on top only)
- 2ff Magnetic Tape Unit (121 lbs.)
- 2e1 Passive Maintenance Device
- 2e Module Test Set (MTS)
- 2d1 Central Processing Unit (CPU) (with 2 people)
- 2a Cables (except power cable, external power to PU - this is difficult (5))
- 2h3 Alphanumeric Keyboard
- 2h2 Display Editor (must be careful with pins, bend easily)
- 2h1 Switch Panel Assembly
- 2g Electronic Line Printer (electronic portion)
- 2d3 I/O Unit (with 2 people)

Moderate (3)
- 2n Digital Data Terminal (on bottom only)
- 2c Power Converter Group (2 person lift)

Moderately Difficult (4)
- 2u Remote Data Terminal

Difficult (5)
- 2v Digital Plotter Map (200 lbs., 4 people)
- 2g Electronic Line Printer (mechanical portion)
- 2d3 I/O Unit (by yourself)
- 2d2 Mass Core Memory Unit (MCMU)

DIFFICULTY OF FAULT DIAGNOSIS (If Performed)

Self-Diagnosis- No Testable Parts
2r Communications Control Unit

None (Visual Inspection)
2e1 Passive Maintenance Device

Easy (1)
2v Digital Plotter Map
2t TACFIRE Communications Interface
2s Remote Control Monitoring Unit
2h3 Alphanumeric Keyboard
2e Module Test Set (MTS)
2q Communications Junction Box
2p Communications Terminal Box (if doesn't work then change filter)

Somewhat Easy (2)
2ff Magnetic Tape Unit

Moderate (3)
2y Power Function Box
2n Digital data Terminal
2h2 Display Editor
2a Cables

Somewhat Difficult (4)
2u Remote Data Terminal
2h1 Switch Panel Assembly
2c Power Converter Group (time-consuming, but not mentally taxing)

Difficult (5)
2x TACFIRE (Diagnostic system program can mislead)
2v1 Digital Control Unit
2g Electronic Line Printer (very difficult)
2ff Magnetic Tape Unit (MTT mechanical subcomponent is very hard)
2d3 I/O Unit
2d1 Central Processing Unit (CPU)
2d2 Mass Core Memory Unit (MCMU)

DIFFICULTY OF REPAIR ACTIONS (If Performed)

Performed at Depot Level
  2ff Magnetic Tape Unit

Easy (1)
  2y Power Function Box
  2x TACFIRE
  2v1 Digital Control Unit
  2u Remote Data Terminal
  2t TACFIRE Communications Interface
  2s Remote Control Monitoring Unit
  2n Digital Data Terminal
  2p Communications Terminal Box (except HOC cable connection; hardly ever repair, but very difficult)
  2q Communications Junction Box
  2h3 Alphanumeric Keyboard
  2h2 Display Editor (But hazardous, CRT)
  2g Electronic Line Printer (electronic portion)
  2e1 Passive Maintenance Device
  2d2 Mass Core Memory Unit (MCMU)
  2h1 Switch Panel Assembly
  2e Module Test Set (MTS)
  2d3 I/O Unit
  2d1 Central Processing Unit (CPU)
  2a Cables

Somewhat Easy (2)
  2c Power Converter Group

Moderate (3)
  2r Communications Control Unit

Difficult (5)
  2v Digital Plotter Map (Mechanical adjustments)
  2g Electronic Line Printer (Carbon dust makes electrostatic sensitive components fail, operators don't clean like they're supposed to; also no schematics) (Mechanical Portion)

FREQUENCY OF REFRESHER TRAINING NEEDED IF NOT PERFORMED FREQUENTLY ON THE JOB

None
- 2y Power Function Box
- 2u Remote Data Terminal
- 2t TACFIRE Communications Interface
- 2s Remote Control Monitoring Unit
- 2p Communications Terminal Box
- 2q Communications Junction Box
- 2h3 Alphanumeric Keyboard
- 2e1 Passive Maintenance Device
- 2c Power Converter Group
- 2a Cables

Every 6 Months
- 2r Communications Control Unit
- 2ff Magnetic Tape Unit

Quarterly
- 2n Digital Data Terminal
- 2h2 Display Editor
- 2h1 Switch Panel Assembly
- 2e Module Test Set (MTS)
- 2d3 I/O Unit
- 2d2 Mass Core Memory Unit (MCMUO
- 2d1 Central Processing Unit (CPU)

Every 2 Months
- 2v1 Digital control Unit (all very unique cards)
- 2v Digital Plotter Map

Daily
- 2g Electronic Line Printer

DIFFICULTY OF SKILL ACQUISITION

Easy (1)

2u Remote Data Terminal
2s Remote Control Monitoring Unit
2q Communications Junction Box
2p Communications Terminal box
2h3 Alphanumeric Keyboard
2e1 Passive Maintenance Device
2e Module Test Set (MTS)
2c Power Converter Group
2a Cables
2t TACFIRE Communications Interface

Somewhat Easy (2)

2y Power Function Box
2h1 Switch Panel Assembly
2ff Magnetic Tape Unit

Moderate (3)

2n Digital Data Terminal
2h2 display Editor
2d1 Central Processing Unit (CPU) (a lot of theory, taught too long after fundamentals)
2d2 Mass Core Memory Unit (MCMU)

Difficult (5)

2x TACFIRE
2v Digital Plotter Map (not enough taught in school)
2v1 Digital Control Unit
2r Communications Control Unit (must know how to operate as well)
2g Electronic Line Printer (must learn forever)
2d3 I/O Unit

39Y TRAINING JUDGMENTS

SKILL ACQUISITION DIFFICULTY AND REFRESHER TRAINING NEEDS

39Y MAINTENANCE ACTIONS:

FREQUENCY AND DURATION

FREQUENCY OF REPAIRS

Whenever someone messes it up
- 2e1 Passive Maintenance Device

Twice a Month
- 2n Digital Data Terminal
- 2q Electronic Line Printer

Every Month
- 2ff Magnetic Tape Unit
- 2d3 I/O Unit
- 2d2 Mass Core Memory Unit (MCMU)

Every 3 Months (Quarterly)
- 2x TACFIRE
- 2ff Magnetic Tape Unit (depends)
- 2a Cables

Every 4 Months
- 2v1 Digital Control Unit
- 2v Digital Plotter Map

Every 6 Months
- 2u Remote Data Terminal
- 2h2 Display Editor
- 2h1 Switch Panel Assembly
- 2c Power Converter Group

Yearly
- 2e Module Test Set (MTS)

Every 2 Years
- 2y Power Function Box
- 2p Communications Terminal Box
- 2q Communications Junction Box

Every 3 Years
- 2s Remote Control Monitoring Unit

Every 5 Years
- 2t TACFIRE Communications Interface

DURATION OF REPAIRS - Given spare parts available and no interruptions

5-10 Minutes
  2s Remote Control Monitoring Unit

15 Minutes
  2p Communications Terminal Box
  2q Communications Junction Box
  2u Remote Data Terminal
  2e1 Passive Maintenance Device

15 Minutes to 1 Hour
  2r Communications Control Unit (operations actions frequent)

1 Hour
  2h3 Alphanumeric Keyboard
  2ff Magnetic Tape Unit (capstand)

1 to 3 Hours
  2c Power Converter Group
  2a Cables

2 Hours
  2t TACFIRE Communications Interface
  2h2 Display Editor
  2e Module Test Set (MTS)

2 Hours to 2 Days
  2n Digital Data Terminal
  2h1 Switch Panel Assembly

2 Hours to 1 Week
  2d2 Mass Core Memory Unit (MCMU) (If core, shipped to depot)
  2v1 Digital Control Unit (better if 2 work on it)

2 Hours to 2 Weeks
  I/O Unit

2 Hours to a Month (2 men; failures are often intermittent and difficult to diagnose)
  2d1 Central Processing Unit (CPU)

3 Hours
  2y Power Function Box

4 Hours to a Week
  2v Digital Plotter Map

2 Days
  2ff Magnetic Tape Unit (other repairs)

2 Days to 2 Weeks
  2x TACFIRE

39L TASK PER EQUIPMENT ITEM JUDGMENTS

DIFFICULTY OF REMOVE AND REPLACE ACTIONS

Easy (1) - Note: all judgments fell into this category

- 1d Battery Computer System (BCS) for Fire Direction System (FDS) of MLRS and Lance
- 1a AN/PSG-2A Digital Message Device (DMD)
- 1b AN/PSG-4 DMD
- 1c AN/PSG-5 DMD
- 1q Message Device Platoon Leader Digital (MLR)

DIFFICULTY OF FAULT DIAGNOSIS (If Performed)

Easy (1)

- 1d Battery Computer system (BCS) for Fire Direction Systems (FDS) of MLRS and Lance
- 1a AN/PSG-2A Digital Message Device (DMD)
- 1b AN/PSG-4 (DMD)
- 1q Message Device Platoon leader digital (MLR)

Somewhat Easy (2)

- 1c AN/PSG-5 (DMD)

DIFFICULTY OF REPAIR ACTIONS (If Performed)

Easy (1) - Note: all judgments fell into this category

- 1d Battery Computer System (BCS) for Fire Direction Systems (FDS) of MLRS and Lance
- 1a AN/PSG-2A Digital Message Device (DMD) (2 Soldiers)
- 1b AN/PSG-4 DMD
- 1c AN/PSG-5 DMD
- 1q Message Device Platoon Leader Digital (MLR)

39L TRAINING JUDGMENTS:

SKILL ACQUISITION DIFFICULTY AND REFRESHER TRAINING NEEDS

DIFFICULTY OF SKILL ACQUISITION

Easy (1) - Note: all judgments fell into this category

1d Battery Computer system (BCS) for Fire Direction Systems (FDS) of MLRS and Lance

1a AN/PSG-2A Digital Message Device (DMD)
1b AN/PSG-4 DMD
1c AN/PSG-5 DMD
1q Message Device Platoon Leader Digital (MLR)

FREQUENCY OF REFRESHER TRAINING NEEDED IF NOT PERFORMED FREQUENTLY ON THE JOB

None

1b AN/PSG-4 DMD
1q Message Device Platoon Leader Digital (MLR)

Quarterly

1d Battery Computer System (BCS) for Fire Direction Systems (FDS) of MLRS and Lance (if don't play tapes)

39L MAINTENANCE ACTIONS:

FREQUENCY AND DURATION

FREQUENCY OF REPAIRS

4 per Week
  1a   AN/PSG-2A Digital Message Device (DMD)

Every 2 Weeks
  1c   AN/PSG-5 DMD

Every 3 Weeks
  1d   Battery Computer System (BCS) for FDS of MLRS and Lance - software

Once a Month
  1d   Battery Computer System (BCS) for FDS of MLRS and Lance - hardware

Every 2 Months
  1b   AN/PSG-4 DMD
  1q   Message Device Platoon Leader Digital (MLR) (MLRS not authorized in TOE)

DURATION OF REPAIRS - Given spare parts available and no interruptions

1 1/2 Hours
  1a   AN/PSG-2A Digital Message Device (DMD) (to repair and inspect)

4 Hours
  1c   AN/PSG-5 DMD

Working Paper FG 90-202

MILITARY OCCUPATIONAL SPECIALTY (MOS) 29M AND MOS 29V MERGER ACTION: A CASE STUDY

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MILITARY OCCUPATIONAL SPECIALTY (MOS) 29M AND MOS 29V MERGER ACTION: A CASE STUDY

CONTENTS

CONTENTS (Contined)

List of Figures

MILITARY OCCUPATIONAL SPECIALTY (MOS) 29M AND MOS 29V MERGER ACTION: A CASE STUDY

Introduction

As part of a research effort sponsored by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) under Contract No. DAHC35-89-D-0028 into MOS restructuring techniques, Akman Associates, Inc. (AKMAN) performed a MOS action in order to understand the restructuring process and identify methods for improvement. Between ARI, the Signal Branch, and AKMAN, the creation of a new MOS 29V as a result of merging MOS 29M and MOS 29V was selected for analysis. The focus was on Standards of Grade Authorization (SGA) development and supporting procedures. This working paper documents the procedures used in the MOS 29M and MOS 29V merger action for developing the SGA table and supporting documentation used in analytical procedures related to MOS restructuring. It is one of several reports under a research effort focusing on the development of methodologies and techniques that can be used to restructure proponent MOSs and Career Management Fields (CMFs). A major thrust of this effort is the demonstration of the feasibility of computer-aided restructuring analysis techniques. While the focus in this report is on the Signal Branch, the research and findings have general applicability to all Army personnel proponents.

This report establishes a procedural baseline of the techniques used in developing the SGA segment of a MOS action. This portion of a MOS study consumes fifty to ninety percent of the development time required in preparing the entire action. This effort conforms to the procedures employed by the Signal proponent in 1989. During the preparation of the SGA table and supporting documentation for MOS 29V, Microwave Systems Repairer, these procedures were further refined and new processes developed. As a result of this effort, the SGA table was produced, a MOS action plan was developed, and the feasibility of using a computer to aid the development of the SGA table was demonstrated. The action plan is described in a separate report (Haught and Loungeway, 1990).

Background

The Signal proponent routinely engages in MOS restructuring studies. These studies examine existing Signal MOSs in light of new equipment acquisition and fielding as well as changes in doctrine, organizational structure, or MOS tasks. Recommendations to merge or delete existing MOSs and Additional Skill Identifiers (ASI), or create entirely new MOSs and ASIs result from the restructuring studies.

Currently, formal restructuring studies required by Military Occupational Classification Structure Development and Implementation, Army Regulation (AR) 611-1, are labor-intensive. The procedures that must be performed are done manually, and thus prone to error. They primarily involve manually converting reports from The Army Authorization Documents System (TAADS) and Tables of Organization and Equipment (TOE) into the formats for submission required by AR 611-1. Furthermore, the sheer volume of work coupled with its complexity makes timely completion of restructuring studies difficult.

The guidance provided by the Military Occupational Classification Structure (MOCS) Handbook describes the steps which must be executed but does not provide specific procedures for MOS restructuring. ARI sponsored the present effort as a basis for developing more systematic and quantitative methods to use in performing the analysis required by the MOCS Handbook and related Army guidance.

Overview of Report

This working paper consists of three sections. First, the current procedures for executing the work unit count and developing the SGA are described. By outlining the methods currently used by the proponent, this section provides the background information with which to compare against the automated restructuring analysis methods described in the following section of the working paper.

Second, the methodology by which the SGA table was developed for the MOS 29M and MOS 29V merger action is detailed. Both manual and computer-aided analyses were used. This section demonstrates that automating many of the currently manual computations involved in SGA development has potential benefits in time savings and error reduction. Data requirements, data base structures, and data base analyses necessary to automate major portions of SGA development are described.

The last section presents a summary of the findings and conclusions. The SGA table completed for the case study is discussed. Computer-aided SGA development is compared with the current procedures. Finally, the feasibility of automating a number of analyses involved in MOS restructuring activities is explored.

Current Practices

This section describes the SGA development process of MOS restructuring analysis as it is currently performed by the Signal Branch. This description provides a baseline against which the automated procedures presented later in this working paper can be compared.

This section first provides a historical perspective on MOS restructuring analysis. Over the past few years, a number of changes have been implemented in the amount and detail of information required by regulation to support MOS restructuring. These have had a dramatic effect on the workload associated with routine MOS restructuring activities. This section describes these changes and their implications for how SGA development must currently be performed and documented.

Second, this section describes the current process for performing the work unit count. The work unit count is an essential step in the SGA development process as it provides data necessary for SGA development. The method by which work unit counts are currently performed directly affects all subsequent SGA development activities. This method is described and its implications for SGA development are discussed.

Finally, this section describes the methods employed to develop the SGA table and its supporting documentation. The SGA table is a final product resulting from the data contributed by several analytical processes. These processes are identified, the methods are outlined, and their significance in the SGA process is explained.

Background

The procedures used by the Signal proponent in developing MOS actions have undergone evolutionary change during the eight years since the proponent's establishment. These changes have resulted in a tremendous increase in the amount of analysis required to restructure Signal Branch MOSs. This analysis is characterized by the manipulation of large amounts of detailed data using primarily manual processes.

Prior to 1983, only the revised SGA table had to be submitted to the U.S. Army Personnel Integration Command (USAPIC), formerly the Soldier Support Center - National Capital Region when a change in a MOS was proposed. USAPIC routinely waived the regulatory requirement to submit the supporting documentation. Since 1983, USAPIC has required the submission of all supporting documentation required by AR 611-1. This means that tremendous amounts of manhours have to be devoted to converting reports from TAADS and TOE into the required formats

for submission. All affected lines from the base TOEs and the Tables of Distribution and Allowances (TDA) positions in TAADS must be transcribed to the proposed change worksheets in the format required by AR 611-1. On average, approximately 12-18 man-months of effort are necessary to prepare an MOS action using the manual processes currently available.

Efforts have been made to automate some of these manual processes. Minor improvements have been made since 1984 in the processing of the proposed worksheets through utilizing a word processing center; however, extensive editing and corrections are still necessary. Initial efforts at retrieval of the Signal Corps TAADS data in an automated mode were tried by the proponent office as early as 1983. Data were compiled and provided on eight-track magnetic tape. However, the data support activity at Fort Gordon could not convert these data for usage on a desktop computer and very few desktop computers were even available until 1986.

The CMF 74 Automatic Data Processing restructuring study in 1987 and 1988 used the first successful conversion of TAADS data from eight-track magnetic tape onto floppy disk. This conversion allowed TAADS data to be manipulated with data base software on personal computers (PCs). This provided the first positive step in replacing the manual approach to MOS restructuring analysis.

For several recent MOS restructuring studies, updated TAADS data had to be manually reentered in the data base. Manual entry of this voluminous amount of data is extremely time-consuming. For example, in a recent MOS study in which TAADS data were updated in the data base, two Management of Change (MOC) windows occurred between the initiation and finalization of the study. Since MOC windows occur every six months, the data were over a year out of date by the time the update was finished. However, the analysts believe that the accuracy of the data available after updating and the utility of the data base for analysis justify the time required to revise the data base.

Revised guidance from USAPIC in 1988 and 1989 added new analysis requirements. A requirement to document the Modified Table of Organization and Equipment (MTOE) positions was added to the existing requirements of documenting the base TOE and TDA positions. Also added was a requirement to develop an annotated Personnel Management Authorizations Document (PMAD) report reflecting the conversions for the implementation year plus two additional years.

While these new requirements doubled the analysts' workload during the position analysis and concurrent SGA development, they provided some benefits to the analysts as well. Completion of the PMAD conversion process yielded information that was not previously available. Modified by-grade position data provided

the most accurate MOS by-grade figures for the implementation year yet available to the analyst. These revised numbers became the basis for the SGA analysis reports included in the MOS action.

Current Work Unit Count Procedure

The work unit count is that part of MOS restructuring analysis that provides the foundation for SGA development. Work unit counts determine the size and composition of all work units. Information obtained from this process provides the basis for establishing grade patterns to be included in a SGA table. This procedure must be done whenever a SGA table revision is necessary for a current MOS or when developing a SGA table for a newly established MOS.

The USAPIC MOCS Handbook provides the regulatory information on MOS restructuring analysis and work unit counts. The data requirements for MOS restructuring analysis are the latest approved TAADS document listing MOS by grade and PMAD (current and next two years). During SGA development, a comparison is made at the Unit Identification Code (UIC) level between TAADS and PMAD.

Work unit counts involve intensive review of the authorized MOS positions in TAADS. A matrix of positions by work units is created. The analyst manually places a tally in the matrix cell corresponding to the proper position and work unit level for each MOS occurrence in the TAADS document. The process is described in the MOCS Handbook in the following manner:

"1. Separate the paragraphs in TAADS into the smallest "work unit", i.e., team section, squad, etc. Exclude supervisory, other special or unique grading and civilian positions. Some units will have as few as one military position, some will have as many as 50 or 60.

2. List the number of work units with one position, number with two, etc., and total by size work unit. Every work unit must be accounted for. (The total should equal the number of positions in the TAADS Summary)."

This process is painstaking and labor-intensive due to the sheer volume of data to be examined and recorded. Following the instructions in the MOCS Handbook is not always possible. For instance, when unique grading equates to ASIs that are governed by separate grading tables, excluding these positions from the count results in totals that do not equal the TAADS summary. The positions governed by unique grading must be accounted for on a separate tally sheet, then combined with the original tally sheet to equal the TAADS summary.

There are other drawbacks as well. Once the data are recorded, there is no audit trail back to the TAADS. Furthermore, the entire process is susceptible to data entry error. Very often, two persons performing analysis of the same data using identical procedures obtain different results. As long as the process is manual, even the most experienced analysts will perform at less than 100 percent accuracy.

Current Standards of Grade Development Procedure

The Signal proponent at present follows the SGA development process as outlined in the MOCS Handbook. SGA analysis is performed to attempt to meet the mission requirements and optimize the career pattern of an MOS. It involves reviewing skills and supervision requirements associated with authorized positions for the purpose of assigning appropriate ranks to those positions. The analysis also leads to decisions about the skill level at which the MOS will start and what, if any, ASIs or Special Qualification Identifiers (SQIs) should be associated with the MOS. SGA analysis is iterative; the basic grade pattern is adjusted to incorporate constraining factors until the notional grade pattern represents the optimal solution, given those constraints, when evaluated against TAADS and PMAD. Outputs from position data analysis, performed earlier in the MOS restructuring analysis, are critical to the SGA process as they define the mission requirements of the MOS.

The initial establishment of the grading pattern is accomplished using a SGA development worksheet. This worksheet requires data be gathered from the work unit count process and from PMAD. Once the initial grading pattern is established, the draft SGA table is prepared.

Both manual and automated methods are used to develop the draft SGA table. The use of automated data base processing is at the discretion of the analyst. Some analysts enter all changes manually by writing directly on the TAADS and PMAD reports. Others use data base software, applying and recording the changes in data bases. Recording and tracking all position grading changes in the first instance is done manually on tally sheets. Tracking in the latter process requires the use of commands which link the required data bases.

The grading patterns depicted by the proposed SGA may require adjustment many times before the best balance in terms of SGA-to-mission and SGA-to-force structure requirements mix is found. Each time changes are made to the grading pattern of the SGA, the SGA must be reapplied to both TAADS and PMAD to determine force structure implications and the best fit with the average grade matrix. This process is very time consuming when done manually.

The final version of the SGA table is submitted to USAPIC for approval. Supporting the table are revised versions of the

authorization documents affected by the SGA. The final submittal includes the proposed SGA table with the appropriate TAADS and PMAD documents, which have been modified to reflect the changes in the SGA.

TAADS documents reflecting the numbers in the final SGA table are prepared manually or retrieved from the data base and printed as an output report. The manual process is labor intensive and the documents normally are difficult to read due to the number of changes entered on them. Reports generated from data bases require little time to retrieve and are easy to read.

The TOE positions affected by the MOS analysis must also be converted once the SGA table is finalized. The only process currently available to convert the TOE extracts used by the Signal proponent for recording the TOE changes is to manually write the changes on the reports.

Finally, a PMAD report, also reflecting the new SGA table, is submitted with the action documentation. This report is manually prepared. A summary of MOS changes by-grade at the end of the report is developed using two different methods. In the first process, the proponent analyst tracks the MOS authorization differences between TAADS and PMAD, as well as the by grade changes, using tick marks on a tally sheet. At the end of the entry process all the numbers are totalled with a calculator. A second method involves establishing a specialized data base to track changes. Totals are generated using a data base command upon completion of the process. The revised summary of the MOS by grade provides the necessary information to complete the grade structure analysis reports required by the MOCS Handbook.

Work Unit Count and SGA Methodology

This section presents the methodology and results of the analysis for the merger of MOS 29M and MOS 29V to create a new MOS 29V. Data base development, work unit count, and SGA development are discussed.

The first subsection describes data base development and how the SGA development processes were adapted for use on a PC. Data sources required to perform the analysis and their automation are discussed.

Second, procedures used to create the work unit count to support subsequent SGA development are explained. This subsection describes the results of the analysis and the benefits derived from automating the work unit count process.

The last subsection presents the methodology employed in developing the final product, the SGA table. This subsection describes the analysis steps necessary to merge MOS 29M and MOS 29V, the interdependence of the data sources used in the analysis process, and the benefits gained by automating parts of that process. The results of the SGA development and the final SGA table for the MOS merger are presented.

Data Base Development

Data bases developed during the MOS 29M and MOS 29V merger action analysis demonstrated the feasibility of automating some of the traditionally labor-intensive manual processes associated with MOS restructuring analysis. The purpose of placing data into computerized data bases was to provide the analyst with instant data retrieval capability to facilitate MOS restructuring analysis. Of particular interest in this investigation was the feasibility of automating the work unit count supporting SGA development.

The development of MOS restructuring analysis data bases is discussed in terms of the data required to support the SGA development process. These data are standard Army authorizations documents that are traditionally provided in hardcopy format. Following is a description of the data sources required to support SGA development and an explanation of the process of converting the data from the source documents for use on a PC.

Tailored TAADS reports. MOS restructuring analysis and SGA development, in particular, requires the analyst to perform a review of all personnel authorizations of the affected MOS(s). It is accomplished by reviewing the authorizations contained in the latest approved TAADS documents. TAADS data can be retrieved as a printed report or on data tape. The printed report has been the method used by the Signal proponent in the majority of its MOS actions; however, the Signal proponent is currently developing a process to retrieve all Signal Corps authorizations

in tape format after each MOC window. When this is accomplished, TAADS information will be immediately available at each analyst's work station, enhancing the proponent's capability to quickly answer enquiries and analyze position information.

The format for retrieving the TAADS data is specified in the MOCS Handbook. The analyst tailors the data to his specific information needs by ordering detailed TAADS extracts by paragraph title from USAPIC. Both military and civilian positions should appear in each paragraph in addition to the positions of the MOS or MOSs under study. This information is used to analyze the impact of other MOSs or civilian positions on the MOS under study. These data are retrieved as a printed report.

The Office Chief of Signal (OCOS) provided the reports used for the current MOS 29M and MOS 29V analysis investigation. These were the latest approved MOS and grade, by command, as of late November 1989. Individual printed reports were used for MOS 29M, MOS 29T, MOS 29V. An earlier consolidated run was used for select MOS 29W positions.

Recapitulation reports. The second major data requirement for developing a computer-based data base of TAADS data for MOS restructuring analysis is the recapitulation (RECAPS) report. RECAPS provides the total number of authorized and required MOS positions found in TAADS. The RECAPS is broken out by Major Army Command (MACOM) and total TAADS, by grade. RECAPS is essential for verifying the accuracy of the data entered into the data base. RECAPS is ordered as part of the individual MOS reports. The report must be at the individual MOS and grade level of detail, and organized by MACOM.

Developing the data base structure. Data bases were created on a PC using dBaseIII software to facilitate data analyses in support of the MOS 29M and MOS 29V restructuring analysis. Data base file structures were developed to conform to the structure of the TAADS data. Data base fields were created to accept paragraph and line identification, MOS title, unit description, number of authorizations, and other pertinent data from TAADS.

The first step in developing the data base involved defining the file structure. TAADS data are currently available in a format suitable for entry into a computerized data base. A sample of the TAADS extract for MOS 29M is shown in Figure 1. All columns in TAADS, with the exception of "LIC", were selected for inclusion in the data base structure. These columns became fields in the data base. Other fields were added to the data base structure to track edited records, show proposed changes, or fulfill other data analysis functions, such as work unit counts. The final data base structure is shown in Figure 2.

SRC	UIC	UNIT DESCRIPTION	PARA	LINE	DUTY TITLE	ID	GR	MOS	ASI	LIC	BR	REQ	AUT	CCNUM	LOC	PARA TITLE
34015J	WERDAA	0204 SIG INTEL	113Y	08	TACSAT/MWAVE REP	I	E5	29M20			NC	1	0	AS0191	GE	C-E MAINTENANCE SEC
			113Y	17	TAC COMM SYS REP	I	E4	29M10				2	2	AS0191	GE	C-E MAINTENANCE SEC
								UIC TOTAL				3	2			
								SRC TOTAL				3	2			
								CMD TOTAL				3	2			
	WCEB99	SC BN AUG	202	08	TACSAT MW REP DJAW	I	E6	29M30			NC	1	1	CZ0191	GE	C-E MAINT SEC
			202	10	TACSAT MW REP DJAW	I	E5	29M20			NC	1	0	CZ0191	GE	C-E MAINT SEC
			202	13	TACSAT MW REP DJAW	I	E4	29M10				3	0	CZ0191	GE	C-E MAINT SEC
			202	15	TACSAT MW REP DJAW	I	E3	29M10				1	0	CZ0191	GE	C-E MAINT SEC
								UIC TOTAL				6	1			
	WCE799	SC CO AUG	106	05	TACSAT/MW SUPV DGAW	I	E6	29M30			NC	2	2	CZ0191	BE	MOBILE LIASION CELL
			106	07	TACSAT/MW REP DGAW	I	E5	29M20			NC	4	4	CZ0191	BE	MOBILE LIASION CELL
			106	12	TACSAT/MW REP DGAW	I	E4	29M10				6	6	CZ0191	BE	MOBILE LIASION CELL
			106	16	TACSAT/MW REP DGAW	I	E3	29M10				3	3	CZ0191	BE	MOBILE LIASION CELL
								UIC TOTAL				15	15			
	WDQ099	SC HHD AUG	106	15	SR TAC MW SYS DMCW	I	E6	29M30			NC	1	1	CZ0191	GE	BN MAINT SECTION
			106	18	TAC MW SYS RPR DMCW	I	E5	29M20			NC	2	2	CZ0191	GE	BN MAINT SECTION
			106	24	TAC MW SYS RPR DMCW	I	E4	29M10				3	3	CZ0191	GE	BN MAINT SECTION
								UIC TOTAL				6	6			
	WFT199	SC HHD BN AUG	107	03	TAC MW SYS RPR DBAW	I	E6	29M30			NC	1	0	CZ0190	6AZ	BN C-E MAINT & INSP
								UIC TOTAL				1	0			
	WOPBAA	1110TH USA SIG BN	007D	03	TAC/MWAVE REP SDKDS	I	E5	29M20			NC	1	1	CZ0191	1MD	ORLANDO, FL TML
								UIC TOTAL				1	1			
	W35SAA	1101ST USA SIG BDE	005C	04	TAC SAT/MWV REPDJAS	I	E5	29M20			NC	1	0	CZ0191	7VA	TRG/SYSCON BR
								UIC TOTAL				1	0			

Figure 1. Extract from Latest Approved TAADS for MOS 29M

Field	Field Name	Type	Width
1	EDIT	Logical	1
2	SRC	Character	6
3	UIC	Character	6
4	UNIT	Character	4
5	DESCRIPTIO	Character	18
6	PARA	Character	4
7	LIN	Character	3
8	TITLE	Character	19
9	GRADE	Character	2
10	MOS	Character	5
11	BR	Character	2
12	ID	Character	1
13	ASI	Character	2
14	CCNUM	Character	6
15	REQ	Numeric	4
16	AUTH	Numeric	4
17	UNIT_LOC	Character	3
18	PARA_TITLE	Character	22
19	NTITLE	Character	19
20	NMOS	Character	5
21	NASI	Character	2
22	NREQ	Character	4
23	NAUTH	Character	4
24	SGALINE	Character	2
25	POS_REQ	Character	2
26	POS_WE6REQ	Character	2
27	SUPV	Character	22
28	TDA	Logical	1
29	POS_AUTH	Character	2
30	POS_WE6AUTH	Character	2

Figure 2. Data Base Structure.

Adding TAADS data to the data base. Data bases were created for MOS 29M, MOS 29T, and MOS 29V using the described structure. Data for each MOS from TAADS were manually typed into the appropriate data bases. Individual paragraph and line entries in TAADS became individual records in the data bases. To ensure data accuracy, RECAPS of the MOS by grade and totals in TAADS were obtained from OCOS and compared with the data in the data base.

Work Unit Count

The effort to merge MOS 29M and MOS 29V presented an opportunity for exploring application of automation to the work unit count process. All work unit position information was recorded and analyzed in the MOS data bases.

Fields were created in the data base for storing work unit size information for each MOS grade level (i.e., E3, E4, E5, and so on). Using the TAADS report, every work unit in MOS 29M was counted and data were entered into the MOS 29M data base. The same procedure was used for MOS 29V, with entries recorded in the MOS 29V data base. The actual work unit counting process was quick and accurate, consisting of calculating the data within grade fields across the data base records.

Three major advantages to automating the work unit count were demonstrated. First, it saved considerable time over the manual work unit count method. Second, the automated work unit count is as accurate as the data in the data base; the manual method of placing tallies on a worksheet is susceptible to analyst error. Third, this procedure establishes a complete audit trail of the sorting and counting of MOS positions. The current manual methods do not provide a means to trace data back to the source document, nor do they provide the level of information and accuracy afforded by the automated method.

SGA Development

Creation of a new MOS 29V by merging MOS 29M with current MOS 29V combining activities, training, and career paths, requires that a new SGA be developed to reflect the change. Development of this SGA was based on analysis of the positions affected by the merger action. It involved comparing existing MOS grading patterns with those in personnel authorizations documents, and creating new MOS grading patterns based on constraints imposed by mission requirements, levels of authorization, and force structure requirements. The merger of MOS 29M and MOS 29V did not change the total number of authorized positions within CMF 29, rather, it required changes to the manner in which those positions were graded in the new MOS resulting from the merger. Thus, the new SGA did not authorize positions; it provided the grade structure for the positions.

The SGA development process required six analytical steps:

1. Determine the projected force strength
2. Determine the ideal grade structure for the MOS
3. Determine the supervisory grading pattern
4. Determine the worker grading pattern
5. Apply the SGA to the authorization documents
6. Prepare the final SGA table.

Figure 3 illustrates the process flow in SGA development and the relationships between data elements created at each stage in the process.

Projected force strength. The first step in the SGA development process was the determination of the projected force strength. This step was performed to identify the baseline manpower numbers, by grade level, with which the analyst was required to work. The final SGA table representing the merger of MOS 29M and MOS 29V contained the number of authorized positions that resulted from this analysis.

Two data sources were required: TAADS and PMAD. A detailed TAADS extract for MOS 29M and MOS 29V was requested from USAPIC. TAADS comes in two different versions: current approved, which describes the current force, and latest approved, which describes the projected force for the following fiscal year in terms of required and authorized positions.

To ensure the SGA to be developed was as current as possible when completed and approved, the latest approved version of TAADS was required. Thus, the SGA was developed using data reflecting the number of positions the MOS was projected to have authorized in the coming fiscal year. To meet the level of detail required in the SGA, the TAADS extract needed to contain full paragraph data, which means data for all positions in each workcenter. PMAD data for the MOSs was obtained through USAPIC. This document contained the authorized positions for the current year and projections for the following six fiscal years.

Determining the projected force strength required a comparison of the number of authorizations in TAADS with those in PMAD at the Unit Identification Code (UIC) level of detail. This comparison between TAADS and PMAD was repeated for the current year and the following three fiscal years for each MOS. Since the goal of this analysis was to determine the baseline number of authorizations within the MOSs to be merged, any discrepancies between TAADS and PMAD had to be accounted for. Thus, when the number of authorizations in a particular unit in TAADS did not match the number for the same unit in PMAD for, say, FY92, the discrepancy had to be investigated. Typically, this type of difference was due to programmed changes in unit missions that affected required manning of those units for the future.

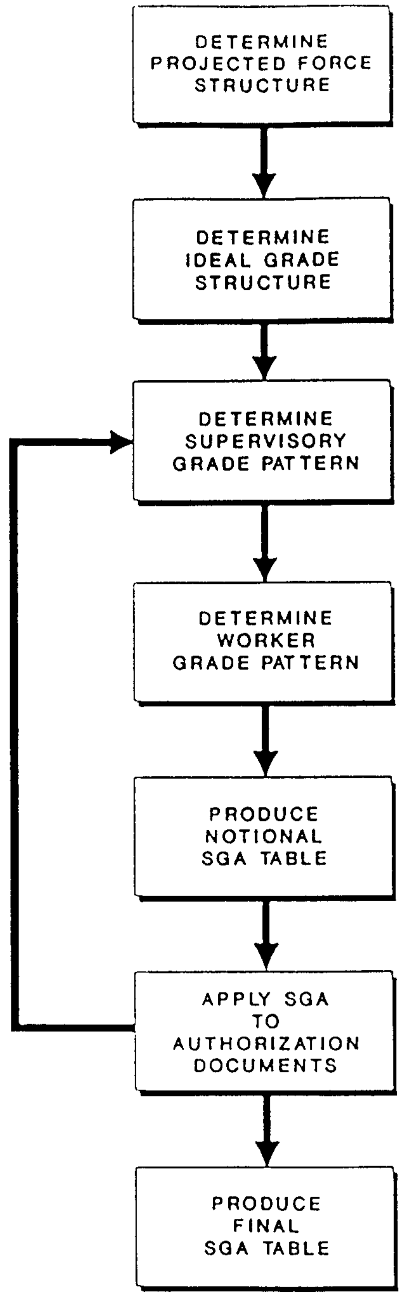

Figure 3. SGA Development Process Flow.

Actual counting of authorizations within TAADS was facilitated by the data bases developed for the work unit count described previously. Files were sorted by grade level within UIC fields and the data were totalled. PMAD authorizations had to be manually counted, as they had not been converted to data base format. The comparisons between TAADS and PMAD summaries were also performed manually.

The result of the projected force strength comparison analysis was a total number of authorizations for the two MOSs for the outyears, detailed by grade. These numbers were the basis for the rest of the SGA development, as they described exactly how many positions would be available, in total and at each grade level, when MOS 29M and MOS 29V were merged.

Grade structure. The second step of the SGA development process was the identification of the ideal grade structures for the MOS created by the merger action. A healthy grade distribution provides a balanced ratio of supervisors to workers and a career environment in which personnel can advance through the grades. This distribution is characterized by a pyramidal shape in which there are progressively smaller numbers of each higher enlisted grade. This pyramidal structure optimizes promotion potential while ensuring that personnel have adequate time to gain experience at each grade level, resulting in a stable MOS, and ultimately, CMF.

One of the goals of the merger action was to create a grade structure for the new MOS 29V that was as close as possible to the ideal grade structure while meeting mission requirements. A redistribution of functions among MOS grades was necessary to achieve a balance between a healthy grade distribution and an effective distribution of task responsibilities.

Since the assignment of grades had to be based partly on mission requirements, it was necessary to determine the current status of the affected MOSs in terms of their duties, where they are deployed within the Army force structure, and their current grade structure.

In the current CMF 29, MOS 29V is responsible for the operation and maintenance of fixed strategic microwave terminals. Maintenance is performed through the intermediate direct support (IDS) level. The authorized positions for MOS 29V are found primarily in Echelons Above Corps (EAC) units or activities.

MOS 29M is responsible for the maintenance of tactical microwave terminal equipment. Maintenance is performed through the direct support (DS) level. The authorized positions for MOS 29M are found in units or organizations at Corps level and below.

MOS 29V currently progresses to MOS 29T after grade E6. Positions in this capper MOS are found in the force from Corps through EAC. MOS 29T personnel perform supervisory functions

two areas: strategic microwave equipment repair and strategic satellite communications systems operation. Since a large percentage of the total number of positions authorized at grades E6 and E7 in this MOS are installers, drill sergeants, instructors, and recruiters, separate SGA tables are required in addition to the primary one for the MOS.

Comparison of MOS 29M and MOS 29V against the average grade distribution matrix from the MOCS Handbook determined that there were too many authorizations at grade E6 (overgrading) and too few at grades E3 to E5, the worker grades (undergrading). This structure resulted in a MOS career path in which personnel progressed quickly to the E6 level, then stagnated, as there was no room for the large numbers of E6s to progress to E7. In general, when there is overgrading at any supervisory position, personnel in those supervisory positions must perform tasks that are more appropriate for those with less training and experience. The new SGA tables had to address the overgrading of current positions because the overgrading problem would transfer to the new MOS when MOS 29M and MOS 29V were merged.

The average grade distribution matrix was the source for the ideal grade structure. It expressed ideal grade structure in terms of percentages of the total number of spaces in the MOS by each grade level. From this table, it was determined that the grade structure resulting from the merger of MOS 29M and MOS 29V should correspond to the following pattern:

E3	23.902%
E4	32.846%
E5	20.464%
E6	14.032%
E7	8.756%

Since MOS 29M and MOS 29V were overgraded at grade E6 by 68 percent, the basic thrust of the new SGA development was to downgrade the MOSs to make them more consistent with the Army ideal, expressed in the average grade distribution matrix.

Supervisory position grading pattern. The third step in the development of the SGA for the MOS 29M and MOS 29V merger was the development of the supervisory grading pattern. A specific goal was to address the E6 overgrading problem discovered in the previous phase of the analysis. Two substeps were required: 1) determine number of available positions at each supervisor grade, and 2) assign grades to positions. The number of supervisory level grades is constrained by Congress and the DoD. In general, these stringent constraints allow less latitude in assigning grades to positions than do the constraints on the worker grades, therefore, the grading requirements of supervisory positions have to be determined before those of worker positions.

The number of supervisory positions that could appear in the new MOS was derived from the total number of positions after the

merger (force strength analysis) and the percentage of each grade allowed, provided by the average grade distribution matrix. These percentages were applied to the total number of positions in the modified MOS 29V to create a table showing how many positions could be graded E6, how many graded E7, and so on, down to the worker grades.

Assignment of grades to positions was based upon mission requirements and staff or supervisory needs of the unit in which a particular work center was found. The process was constrained by the total number of positions authorized for each grade. The method used to assign grades to positions involved a) determining the number of personnel supervised by a particular grade, b) determining the level of responsibility of the position (e.g., MACOM staff position, instructor), and c) determining whether the position was a principle NCO position (e.g., detachment NCO, advisor). In general, the higher the supervisory responsibility, the higher the grade assigned to the position. The result was a table of supervisor grades for the new MOS and the number of spaces to be assigned to each grade.

Worker position grading pattern. The fourth step in the development of the SGA for the MOS 29M and MOS 29V merger was the development of the grading pattern for the worker grades, grades E3 to E5. As with the supervisory positions, the goal of the worker grade pattern development was to closely approximate the average grade distribution matrix while creating a structure to meet mission requirements.

Data from the previously developed work unit count were the source for this analysis. The work unit count had resulted in a table that summarized all of the worker positions of the MOS by work unit position. Using this summary, a grading pattern was developed by assigning grades to each work unit position to ensure that the total number of spaces representing each grade were as close to the average grade distribution projections as possible.

Although maintaining a proper numerical distribution between grades was important, several other considerations also influenced the grading of work unit positions. The level of experience required in a job was considered. For example, a work unit containing a single position could not be graded E3, as the average E3 would not have the level of experience necessary to perform the duties of that position. Thus, the first position of the SGA had to be graded higher than E3. Another consideration when assigning grades to positions was to ensure no gaps were created between grades. An SGA could not be developed in which a work unit had E3s and E5s, but no E4s.

The results of this grading were converted into a proposed, or notional SGA table. For each duty position and rank, the grade assigned to a position in the work unit count summary was transferred to the corresponding work unit position in the SGA

table being developed. Thus, for a Microwave Systems Repairer, SP4, the first position in the SGA table was marked because the first position of the work unit count summary was graded E4. This process was repeated until the SGA table was completed for all duty positions and ranks of the new MOS 29V.

Grading of positions in the work unit count summary was a manual process. The notional SGA table was built using a word processor. Because numerous modifications to the SGA table are required in later phases of the SGA development, the ease with which changes can be made with a word processor made it an ideal tool for creating the SGA table.

Application of the SGA. The fifth step in the development of the SGA was the application of the notional SGA to the authorization documents. This involved applying the numbers from notional SGA to each paragraph in TAADS and each UIC in PMAD to determine the effect of the new SGA on the units described in those documents. This was done to ensure that the proposed SGA provided a grade structure within the allowable deviation from the average grade distribution at each grade level and that mission requirements could be met with the new grade structure. The application of the notional SGA to the authorization documents allowed adjustments to be made to accommodate constraining factors such as grade ceiling constraints, mission requirements, training requirements, special skill needs, and career progression concerns. The TAADS data bases created for the work unit count were used to perform some of this analysis. The PMAD report used was in hardcopy format.

SGA analysis was iterative. The grading pattern was adjusted to incorporate constraining factors until it represented the optimal solution, given those constraints, when evaluated against TAADS and PMAD. This was done by 1) modifying TAADS, 2) counting positions by grade, 3) matching the new count with the average grade distribution, 4) evaluating mission requirements, and 5) adjusting the SGA table to conform to mission and distribution requirements.

The initial draft SGA table prepared for this investigation required multiple revisions before it was finalized. First, the TAADS data bases for MOS 29M and MOS 29V were modified using the notional SGA table for the new MOS 29V. On a unit by unit, position by position basis, the authorizations in TAADS were changed to reflect the new SGA.

Second, the numbers in the modified TAADS were totalled by grade to create a by-grade summary of all positions in the new MOS 29V. The summary was generated from the modified data bases by sorting on the grade fields and calculating the totals of those fields.

Third, the by-grade summary was compared against the average grade distribution matrix. For each grade, the numbers of

positions had to be within plus or minus two percent of those calculated by the average grade distribution. If all grades were within these limits the SGA would be considered correct. However, significant deviations from these limits would have to be corrected by rebuilding the SGA table with a different distribution of grades or justifying the deviation on the basis of mission requirement. Therefore, upon each application of the notional SGA to TAADS and PMAD, deviations from the prescribed limits were investigated, and corrections to the SGA were made based on the mission requirements at the work unit level of detail. Since the total number of positions in the higher grades was constrained, changes in grade structures within work units generally required trade offs between work units. For example, 30 positions that had been graded E6 before the merger were downgraded to E4 after the merger. However, when additional E7s were required to supervise personnel or to meet missions which had changed, these positions had to be traded with E7 positions in other work units within the MOS; they could not be created.

The grading patterns represented by the first SGA table required several adjustment cycles before the best solution of grade structure to mission was determined. Each time a change was made to the grading pattern in the SGA, it was reapplied to TAADS and PMAD to determine the force structure implications and goodness of fit with the average grade distribution matrix. Figure 4 illustrates several SGA iterations, and the summary data each produced when applied to TAADS.

Final SGA table. The last step in the development of the SGA Table reflecting the merger of MOS 29M and MOS 29V was the finalization of the SGA table and the preparation of the supporting documentation. Proposed TAADS changes, an annotated PMAD report, and grade structure analysis reports were developed. The proposed TAADS modifications were prepared through the use of a retrieval report from the data base used for the analysis. PMAD was annotated manually. The grade structure analysis report was manually prepared using data summaries from various data bases used to develop the work unit count. The final grade structure analysis report is shown in Figure 5.

The result of this last step of the development process was the SGA table reflecting the merger of MOS 29M and MOS 29V, shown in the Appendix. The final SGA table accomplishes the following:

- Merges MOS 29M and MOS 29V,
- Creates grade E7 for MOS 29V,
- Provides explicit grading instructions for both TOE and TDA facilities,
- Provide career progression in MOS 29V through grade E7, rather than E6.

1. INITIAL SUMMARY INFORMATION

GRADE	E3	E4	E5	E6	E7	E8	E9	TOTAL
TAADS	169	403	358	335	159*			1424
MATRIX	340	468	291	200	125			1424
DELTA	171	65	-67	-135	-34			0

* MOS 29T conversion to MOS 29V

2. REVISED SUMMARY INFORMATION AFTER FIRST SGA APPLICATION TO TAADS

GRADE	E3	E4	E5	E6	E7	E8	E9	NEW TOTAL
NAUTH	218	463	291	307	129			1408
MATRIX	337	462	288	198	123			1408
DELTA	119	-1	-3	-109	-6			0

3. REVISED SUMMARY INFORMATION AFTER SECOND SGA APPLICATION TO TAADS

GRADE	E3	E4	E5	E6	E7	E8	E9	NEW TOTAL
NAUTH	271	481	314	214	131			1411
MATRIX	337	463	289	198	124			1411
DELTA	66	-18	-25	-16	-7			0

Figure 4. Application of SGA to TAADS and Average Grade Distribution Matrix.

GRADE STRUCTURE ANALYSIS REPORT
MOS 29V

	E3	E4	E5	E6	E7	E8	E9	TOTAL
PMAD FY91	91	184	184	226				685
Converted to MOS 31L		-9						-9
Adjusted MOS 29V	91	175	184	226				676
Converted from MOS 29M	+80	+221	+176	+111				+588
Converted from MOS 29T					+154			+154
Converted from MOS 29W					+5			+5
Adjusted PMAD	171	396	360	337	159			1423
Proposal	278	484	311	215	135			1423
Average	340	467	291	200	125			1423
Top Five Impact			-49	-122	-24			

Figure 5. MOS 29V Grade Structure Analysis Report.

The new SGA table provides the basis for determining equitable grades for positions within the MOS created by the merger of MOS 29M and MOS 29V. It provides the guidance necessary to determine what positions require what level of worker or supervisor while ensuring that the overall distribution of grades in the MOS conforms to mission requirements. In meeting this goal, the SGA table also provides guidance in determining a MOS grade distribution that ensures a healthy MOS through proper career progression. To meet the new mission and supervisory requirements of the MOS, the SGA table provides for an E7 grade that did not appear in either original MOS, thus, a career progression within the new MOS to grade E7.

Conclusions

This section presents a summary of the findings of the working paper and the conclusions derived from the case study of the MOS 29M and MOS 29V merger action.

SGA Table

A major product of the case study of the merger of MOS 29M and MOS 29V was the SGA table developed for the action. It provides a basis for grading authorized positions in a newly merged MOS 29V. This grade structure is designed to support the mission and task requirements of the work units in the new MOS by providing positions graded with the appropriate skills for those missions and tasks. The SGA table also provides career opportunities by creating an equitable career progression path through the new MOS.

Automation of SGA Development

SGA development using the current manual methods consumes a significant portion of the 12-18 man-months of effort required for the typical MOS restructuring action. During the MOS 29M and MOS 29V merger action case study, several key, traditionally labor-intensive, steps in the SGA development process were successfully automated. This resulted in considerable savings in time and increases in accuracy over the traditional methods, thereby demonstrating the feasibility and utility of automating processes in SGA development.

The benefits realized by automating these processes for the MOS 29M and MOS 29V merger action case study have implications in all phases of MOS restructuring analysis. It was shown that automating SGA development analyses was possible using PCs and off-the-shelf PC data base software commonly available to the personnel proponents. The benefits derived from this demonstration support the need to investigate the potential of automating other MOS restructuring analysis processes to realize similar accuracy and time savings benefits.

APPENDIX A

STANDARDS OF GRADE AUTHORIZATION TABLE
2-29V-3

APPENDIX A

STANDARDS OF GRADE AUTHORIZATION TABLE 2-29V-3

Table 2-29V-3
Standards of grade authorization

Line	Duty Position	Code	Rank	Number of positions authorized* 1	2	3	4	5	6	7	8	9	10	Explantory notes
1	Microwave systems repairer (MWAVE SYS REP)	29V10 29V1006 29V10V8	PFC			1	1	2	2	2	2	3	3	In TOE
2	Microwave systems repairer (MWAVE SYS REP)	29V10 29V1006 29V10V8	SPC	1	1	1	2	2	2	2	3	3	4	
3	Microwave systems repairer (MWAVE SYS REP)	29V20 29V2006 29V20V8	SGT		1	1	1	1	1	2	2	2	2	NOTE: For 2-5 positions the title is: (MWAVE SYS REP SUPV)
4	Microwave systems repair supervisor (MWAVE SYS REP SUPV)	29V30 29V3006 29V30V8	SSG						1	1	1	1	1	
5	Microwave terminal operator/repairer (MW TML OPR/REP)	29V10	PFC			1	1	2	2	3	3	3	4	In TDA/MTOE, for opertion and maintenance of a DCS, non-DCS microwave terminal site.
6	Microwave terminal operator/repairer (MW TML OPR/REP)	29V10	SPC	1	1	1	2	2	2	2	3	3	3	
7	Microwave terminal operator/repairer (MW TML OPR/REP)	29V20	SGT		1	1	1	1	1	1	1	2	2	NOTE: For 3-5 positions the title is: (MW TML SUPV)
8	Microwave terminal supervisor (MW TML SUPV)	29V30	SSG						1	1	1	1	1	
9	Microwave terminal supervisor (MW TML SUPV)	29V30	SSG											In TDA/MTOE, Sig Co (DCS, non-DCS operations), for supervision of 4 to 6 military/civilianpersonnel operating/maintaining microwave terminal/site.
10	Microwave terminal repairer (MW TML REP)	29V10	PFC			1	1	1	2	2	3	3	4	In TDA/MTOE, direct support maintenance/repair sec. a. Electronic maint br, Sig Bn, DCS Ops. b. Electronic maint br, Sig Bde, DCS Ops. c. C-E repair sec, USA Garrison, Ft Huachuca. d. C-E maint br, AMSF-PAC. e. C-E maint section. f. Bn maint section. g. Elect maint plt. h. DCS maint. NOTE: For 2-5 positions the title is: (MW TML REP SUPV) NOTE: MTOE refers only to tda aug to MTOE.
11	Microwave terminal repairer (MW TML REP)	29V10	SPC	1	1	1	2	2	2	3	3	4	4	
12	Microwave terminal repairer (MW TML REP)	29V20	SGT		1	1	1	1	1	1	1	1	1	
13	Microwave terminal repair supervisor (MW TML REP SUPV)	29V30	SSG					1	1	1	1	1	1	

Table 2-29V-3
Sandards of grade authorization (cont'd)

Line	Duty Position	Code	Rank	Number of positions authorized* 1	2	3	4	5	6	7	8	9	10	
14	Microwave terminal repairer (MW TML REP)	29V10	PFC			1	1	1	1	2				In MTOE, Sig Maint Support Co (AMSF), Korea, mobile maintenance contact teams.
15	Microwave terminal repairer (MW TML REP)	29V10	SPC	1	1	1	2	2	2	2				
16	Repairer/technical evaluator (REP/TECH EVAL)	29V20C4	SGT		1	1	1	1	2	2				
17	Repairer/technical evaluation team chief (REP/TECH EVAL TM CH)	29V30C4	SSG					1	1	1				
18	Tactical satellite micro-wave systems repairer (TAC SAT/MWAVE SYS REP)	29V10XX	PFC			1	1	2	2					a. In TOE. b. In TDA. Joint Communication Support Element.
19	Tactical satellite micro-wave systems repairer (TAC SAT/MWAVE SYS REP)	29V10XX	SPC	1	1	1	2	2	2					
20	Tactical satellite micro-wave systems repairer (TAC SAT/MWAVE SYS REP)	29V20XX	SGT		1	1	1	1	1					
21	Tactical satellite micro-wave systems repairer (TAC SAT/MWAVE SYS REP)	29V30XX	SSG						1					
22	Microwave communications analyst (MWAVE COMM ANAL)	29V20C4	SGT			1	2							In TDA/MTOE. All positions above three in a para or wide band tech eval team will be graded per this line.
23	Microwave communications analyst (MWAVE COMM ANAL)	29V30C4	SSG		1	1	1							Only one position per para or wide band tech eval team will be graded E6.
24	Microwave communications analyst (MWAVE COMM ANAL)	29V40C4	SFC	1	1	1	1							Only one position per para or wide band tech eval team will be graded E7.

Line	Duty Position	Code	Rank	Explantory notes
25	Microwave repair quality control inspector (MWAVE REP Q/C INSP)	29V20	SGT	In TOE, one position in a Light equipment maint co, QA/QC section; Svc co, col & class, ident inspection sec; Collection & class teams; Ord (Maint) co, 2d shift, QA/QC section; Maint co lt equip IGS, QA/QC section. In MTOE, one position, Sig Maint or Support Co (DCS/AMSF), quality assurance section.

Table 2-29v-3
Standards of grade authorization (cont'd)

26	Microwave systems coordinator (MWAVE SYS COORD)	29V20	SGT	In TDA/MTOE, Signal Co (DCS Ops) when second position rquired in co hqs or ops.
27	Maint coordinator (MAINT COORD)	29V20	SGT	In TOE, Strategic Sig Bde HHC, for second position in Log Section. In MTOE, Signal Bn (DCS Ops) when second position required in Log Section.
28	Microwave systems (MWAVE SYS COORD)	29V30	SSG	In TDA, Signal Bn (DCS Ops), Log Section, one position when required by mission.
29	Microwave communications analyst (MW COMM ANAL)	29V30	SSG	In TDA, performs analysis of strategic microwave systems. For 2nd thru 5th position, the 6th position and above will be graded E5. a. Info Sys Engr Cmd, terrestrial sys br, networks engr br, spectrum engr branch, and cmpt perf eval br. b. Theater Comm Cmd (Europe), tactical sys div.
30	Maint coordinator microwave systems (MAINT COORD MW SYS)	29V40	SFC	In TOE, a. TCC (Army), ACOFS, Log, one position. b. Strategic Sig Bde HHC, one position, log section.
31	Microwave systems repair chief (MW SYS REP CHIEF)	29V40	SFC	In TDA. supervision of 10 or more microwave repair personnel and performs QA/QC. a. Signal Bn (Strategic), elect maint br, and AMSF-PAC. b. Signal Co (Strategic), maint br, and Signal Support Co (Strategic), elect ma pl. c. USA Sig Support Co, Berlin, DCS maint. In TOE. a. Lt eqp mnt company, one position, mwve/multich rep sec. b. Lt eqp mnt company, one position, sig comm equip rep plt. c. Ord (Maint) co 2d shift, one position, mwve/multich rep sec. d. Maint co lt equip IGS, one position, TACSAT/MWAVE rep sec. e. MMC, TA, one position, C-E maint br.
32	Operations NCO	29V40	SFC	In TDA. a. ISEC Bn, Co Operations, one position. b. USACEC, matl intro br, one position.
33	Microwave systems chief (MW SYS CHIEF)	29V40	SFC	In TDA one position in the listed organizations, additional positions use line 29. a. Info Sys Engr Cmd, terrestrial sys br, networks engr br, C2 systems branch, spectrum engr branch, trans sy engr ev fac, perf assessmennt br, amd cmpt perf eval br. b. USAISC, maint mgt br. c. SACEUR Det, as principal detachment NCO. d. Signal Bn (DCS Ops), op & intel sec when required by mission. e. Signal Bde (TCC) Korea, MAIT team, and transmission section.
34	Maintenance coordinator (MAINT COORD)	29V40	SFC	In TDA a. Signal Bn (DCS Ops), S-4 section, log section, cnrtct mgmt branch, maint div, and admin & log sec. b. Signal Bde, TCC, maint div, one position. c. HQ AFCE, maint coor sec, and qc sec one position.
35	Microwave systems supervisor (MW SYS SUPV)	29V40	SFC	In TDA, supervisors 7 or more personnel military or civilian engaged in microwave terminal operations and maintenance. In TOE, one position in strategic M/W sys supv team.

Table 2-29V-3
Standards of grade authorization (cont'd)

36	Site Chief	29V40	SFC	In TDA, principal NCO in charge of DCS, non-DCS sites, Walker, Dartboard, Salem, Palgongsan, Humphreys, Ricmond, Pulmosan, Brooklyn, Changsan, Madison, and Namsan.
37	Microwave communications analyst (MW COMM ANAL)	29V40	SFC	In TDA, Theater Comm Cmd, Europe, 4 positions in tactical systems division. In MTOE, Theater Comm Cmd, Europe, 1 position in comm/sys cont div.
38	Operations training NCO (OP/TNG NCO)	29V40	SFC	In TDA, Signal Bn, AIT Company, as operations sgt when trainees are in microwave repair courses.
39	XMSM DEV NCO	29V40	SFC	In TDA, USASC, one position, trans sy div.
40	TS&E NCO	29V40	SFC	In TDA, USASC, one position, eval division.
41	COMM SYS MNT C	29V40	SFC	In TDA, USASC, one position, new systems training division.
42	TNG MGT NCO	29V40	SFC	In TDA, USASC, one position, operations branch, microwave division.
43	CRS MGMT NCO	29V30	SSG	In TDA, USASC, two positions, operations branch, microwave division.
44	TAC MW REP	29V30	SSG	In TDA, USASC, one position, microwave division.
45	TRNG NCO	29V40	SFC	In TDA, USA Depot Sacramento, one position in res comm trng ofc.
46	INST COORD	29V40	SFC	In TDA, USA Depot Sacramento, one position in reg maint trng si.
47	Microwave operations sergeant (MWAVE OPS SGT)	29V40	SFC	In MTOE a. Signal Bn (DCS Ops), one position, in op and intel sec. b. Signal Bde (TCC), Europe, one position, in op and intel sec. In TOE a. Theater signal cmd (A), one position, signal plans branch b. Strategic sig bde HHC, one position, ops and intel sec. c. Strategic Sig Bn HHD, one position, ops and intel section.

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MILITARY OCCUPATIONAL SPECIALTY (MOS) 29M AND MOS 29V MERGER ACTION PLAN

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MILITARY OCCUPATIONAL SPECIALTY (MOS) 29M AND MOS 29V MERGER ACTION PLAN

CONTENTS

MILITARY OCCUPATIONAL SPECIALTY (MOS) 29M AND MOS 29V MERGER ACTION PLAN

Introduction

As part of a research effort sponsored by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) under Contract No. DAHC35-89-D-0028, Akman Associates, Inc. (AKMAN) performed a MOS action in order to understand the MOS restructuring process and identify methods for improvement. Between ARI, the Signal Branch, and AKMAN, the creation of a new MOS 29V through a merger action involving MOS 29M and MOS 29V was selected as a case study for analysis. The case study is presented in a separate working paper (Loungeway, 1990). A MOS action plan was developed to provide the MOS analyst information related to the purpose and goals of the analysis, required data items, and the critical constraints associated with the merger action. This document presents the MOS 29M and MOS 29V Action Plan developed for the merger action.

Background

The Signal proponent routinely engages in MOS restructuring studies. These studies examine existing Signal MOSs in light of new equipment acquisition and fielding as well as changes in doctrine, organizational structure, or training. Recommendations to merge or delete existing MOSs and Additional Skill Identifiers (ASI), or create entirely new MOSs and ASIs result from the restructuring studies.

The Military Occupational Classification Structure (MOCS) Handbook provides the MOS analyst with guidance on performing formal restructuring studies required by Military Occupational Classification Structure Development and Implementation, Army Regulation (AR) 611-1. It describes the steps which must be executed but does not provide specific procedures for MOS restructuring. ARI sponsored the present effort as a basis for developing more systematic and quantitative methods for performing the analysis required by the MOCS Handbook and related Army guidance.

This document presents a MOS action plan developed to guide the merger of MOS 29M and MOS 29V. It is a management plan for the MOS action. The action plan systematically organizes the analyst's work by identifying the types and sources of data required, defining the specific issues to be addressed, making key assumptions explicit, and identifying the essential elements of analysis. Development of an action plan is not presently a routine procedure in a MOS restructuring analysis.

The action plan consists 12 sections that cover four functional areas: background, scope, methodology, and

administration. The plan defines the work to be accomplished, how the work is to be done, and when the work occurs.

Section 1 of the action plan describes the overall goal or goals of the MOS action. The purpose of the action is briefly, but explicitly, stated to provide a context in which the details of the action are presented in later sections.

Section 2 lists the references required by the MOS analyst. Numerous standards, guidelines, data bases, and other documents are required in an MOS restructuring action. This section presents these to provide the MOS analyst with the background and data necessary to meet the restructuring goals.

Section 3 contains a definitive list of assumptions with which the analyst must be familiar. Constraints, restrictions, and other limitations related to the MOS action are explained to define the boundaries within which the analyst must work. For example, an assumption that the MOS action would conform to Headquarters Department of the Army (HQDA) constraints on enlisted grades would be listed in this section.

Section 4 lists the problems that the MOS action must address. Statements describing deficiencies in the current MOS are listed. These become the specific objectives of the restructuring action.

Section 5 provides explanations of the impact each problem listed in Section 4 has on the current MOS. These impact statements provide the MOS analyst with an understanding of the nature and extent of problems with the current MOS structure and the effect of those problems on the personnel within the MOS.

Section 6 of the action plan states the problems listed in previous sections as explicit objectives of the MOS action. This section combines functional goals of training, mission, and force structure into a coherent plan for the restructuring action.

Section 7 defines the scope of the MOS action to be performed. All areas of consideration for the restructuring action are listed, providing the analyst with information such as the number of duty positions the analysis will encompass and whether the action will be applicable to the Army Reserve or Army National Guard.

Section 8 lists the limitations associated with the MOS action. This section provides the analyst with information useful in planning both technical and administrative details of the restructuring action. For instance, limitations in funding would be described, if applicable to the action, as well as any HQDA restrictions.

Section 9 lists the data sources that are essential to the MOS restructuring analysis. Specific authorization documents, extracts, data bases, and reports required for the MOS action are provided. Instructions on where to get these data are also provided. In addition, any data derived from certain phases of the analysis that feed other parts of the analysis are identified. The specific analyses to be performed and the rationale for the analyses are listed. Finally, the order in which analyses must be performed is outlined.

Section 10 presents the methodology of the MOS restructuring action. The methodology section provides the framework into which all other sections of the action plan are tied. Specific instructions detailing how the analysis should be performed are provided.

Section 11 is devoted to the support and resource requirements of the MOS restructuring action. This section of the action plan includes detailed information on funding and the type and level of support required from outside agencies. This information provides the analyst with information necessary to coordinate data requests with the project schedule, determine project personnel requirements, and arrange subject matter expert assistance.

Finally, Section 12 lists the scheduling, personnel, and project management requirements of the MOS action. This provides the time frame in which the action must be performed and the personnel responsible for the analysis.

The following example presents the MOS action plan developed for the MOS action merging MOS 29M and MOS 29V into a new MOS 29V. It details the essential elements required to perform the restructuring analysis for this MOS merger.

MOS Action Plan

1. Purpose:

Examine the feasibility of merging MOS 29M and MOS 29V as both perform direct support (DS) maintenance of microwave radio equipment.

2. References:

a. AR 351-1, Individual Military Education and Training.

b. AR 570-2, Manpower Authorization Criteria.

c. AR 600-3, The Army Personnel Proponent System.

d. AR 611-1, Military Occupational Classification Structure Development and Implementation.

e. Guide for Preparation of Changes to the Military Occupational Classification Structure (MOCS), prepared by Soldier Support Center-National Capital Region, dated 16 March 1989.

3. Assumptions:

a. This review is necessary to determine the impacts of new or revised doctrine, organizations and equipment on MOS 29M and MOS 29V.

b. This proposal is in consonance with the Signal Corps efforts to restructure those Career Management Fields for which it is the proponent.

c. Merger of these two MOSs would partially implement changes as recommended in the 1987, Department of the Army, Military Occupational Study Group report.

d. Revised training to support the new MOS could be accomplished without requiring additional resources from Training and Doctrine Command (TRADOC).

e. The action could be accomplished within the current DA constraints on enlisted grades.

4. Problem(s):

a. MOS 29V is currently a Space Imbalanced Military Occupational Specialty (SIMOS).

b. MOS 29V is short personnel in grades E1-3.

c. The MOS 29M and MOS 29V courses due to introduction of new digital technology in the 29M course are similar in content.

d. The mid eighties restructure of CMF 29 has produced capper MOSs that do not support the needs of the field.

5. Impacts of the Problem(s):

a. Personnel in SIMOS MOSs are adversely affected upon return to CONUS because sufficient spaces in their primary MOS are not always available. Frequently they must work outside of their trained specialty. The Army is penalized as it must add additional authorizations or redesignate current authorizations in CONUS to provide billets for these personnel. The MOS incumbents are further penalized with shorter than normal turn around times between overseas assignments (18 to 30 months versus 36 to 48 months).

b. First termer retention rates in MOS 29V are currently running at 33% versus the Army Average of 49%. The MOS is also short personnel at grades E1-3. The percentage of fill in these grades is not projected to exceed 90% until at least FY 91 based on current Army projections.

c. It is increasingly difficult in a time of short resources to justify to TRADOC two separate courses of instruction which are almost identical in length and teach similar material. The technological gap that existed between the two MOSs in the early and mid eighties has been eliminated with the introduction of the new Digital Group Multiplexing (DGM) equipment in MOS 29M. One course using a generic approach to training would better meet the needs of the Army.

d. Currently personnel in MOS 29Y and MOS 29V progress to MOS 29T upon promotion to grade E-7. The assignment system does not look at the feeder MOS that the 29T MOS holder grew up in. So the normal assignment occurrence is that personnel with ground satellite station experience are assigned to supervision of microwave maintenance facilities and those with extensive microwave maintenance experience to supervision of the ground satellite facilities. This situation results in personnel unable to perform the required duties. Thus the needs of the field commanders are not being met.

6. Objective:

Review and analyze MOS 29M, MOS 29V, and MOS 29T in relationship to the parameters defined in AR 611-1 and AR 600-3. This study will in part ensure that structure, accessions, and training strategies are consistent with current duty position requirements and HQDA grade constraints.

a. Analysis of CMF 29 worksheets based on the current and proposed structure as compared against the Average Grade Distribution Matrix shows that the proposed merger of MOS 29M, MOS 29V, and MOS 29T is feasible and can be accomplished within the current HQDA grade constraints. The resulting structure enhances the posture of CMF 29 and supports the Signal Corps Force Modernization efforts.

b. The Office Chief of Signal (OCOS) proposed training strategy of a merged course for personnel receiving training in MOS 29M or 29V was reviewed by the Microwave Radio Division, Electronic Maintenance Department, Ft. Gordon. From a training stand point the merger can be fully supported.

c. Based on the structure feasibility and training strategy reviews recommend that the effort to merge MOS 29M, MOS29V, and MOS 29T continue. (Note: If the structure analysis or training strategy reviews had produced findings that would not support the merger then at this point the study should stop and new objectives be developed.)

7. Scope:

Areas of consideration will encompass analysis of all duty position requirements and authorizations in latest approved TAADS to determine appropriate grades, for MOS 29M and MOS 29V in the Active Army. The resulting new SGA table will also be applicable to requirements and authorizations in the Army Reserve and Army National Guard.

8. Limitations:

The study results must be submitted in compliance with the <u>MOCS Handbook</u> which provides guidance for developing proposals to change MOCSs. Funding is unavailable for travel in conjunction with this study. HQDA imposed restrictions which restrict any increases in grades without an associated trade-off of equivalent or higher grade are still in effect.

9. Essential Elements of Analysis and Associated Data Sources:

a. Position and Personnel Data Analysis will be conducted utilizing the following data sources:

(1) Functional Review Report, MOS by Grade: Multi-Year Breakout (FRR02), Data Base : PMAD, dated 15 November 1989.

(2) Personnel Authorization Module (PAM), Authorizations Over Time by User-Defined Fields (FRR04), Data Base : PMAD, dated 27 September 1989, Selection Criteria ->MOS: 29M 29T 29V 29W 29Y, FY 89-93.

(3) Latest approved The Army Authorization Documents System (TAADS) extract of MOS: 29M, 29T, 29V, 29W, 29Y, dated 13 July 1989, from U S Army Information Systems Command - Pentagon.

(4) TEP 14 Base Table of Organization and Equipment (TOE) and Living Table of Organization and Equipment (LTOE) extracts, PP Code 2, for MOS 29M, 29V, 29T, 29W. This run must be ordered through OCOS.

(5) TEP 14 Base TOE and LTOE extracts, PP Code 3-6, for MOS 29M, MOS 29V, MOS 29T, and MOS 29W. This run must be ordered through OCOS.

b. A revised job description for MOS 29V will be prepared based on the merged MOCS identifier duties and tasks from MOS 29M, MOS 29V, and MOS 29T. This analysis will be based on the following data:

(1) A Critical Task Site Selection Board will be convened by the Electronic Maintenance Department to select the critical tasks for MOS 29V.

(2) Results from analysis of doctrinal literature.

(3) The results of Position and Personnel Data Analysis.

(4) The latest Army Occupational Survey (AOSP) for MOS 29M, dated February 1988 and MOS 29V, dated July 1988, will be used to the maximum extent possible in developing the specifications for revised MOS 29V.

c. Training Needs Analysis will be completed in order to adequately document the new training strategy for revised MOS 29V. The analysis will be based on inputs from:

(1) Results of MOCS tasks selection.

(2) Revised Individual Training Plan for MOS 29V.

(3) New or revised Course Administrative Data (CAD) and Programs of Instruction (POI) for MOS 29V.

d. A Physical Demands Analysis will be accomplished in order to define the physical work requirements of entry level tasks for MOS 29V. This analysis will be based on the following data:

(1) Results of MOS tasks selection.

(2) Applicable FM's and TM's for MOS 29V.

(3) New or revised POI for MOS 29V.

(4) Observation of Soldiers performing the revised MOS 29V, entry level tasks.

e. Impact on recruiting will be analyzed to ascertain the changes that will need to be made in JOIN. This analysis will be conducted utilizing the following sources of information:

(1) Results of Position Data Analysis.

(2) Results of Personnel Data Analysis.

(3) Results of Critical Tasks Selection.

(4) Results of Physical Demands Analysis.

f. A new SGA for MOS 29V will be developed to meet Army mission requirements and optimize the MOS career pattern. Data sources for SGA development will include outputs from all analysis elements outlined above.

10. Methodology:

a. This study will be performed utilizing the in-progress-review (IPR) process to identify problems and develop recommendations for their resolution. This process may need to be modified due to the distances and time constraints involved.

b. Annotate related studies and any models to be used during analysis.

11. Support and Resource Requirements.

a. TDY funds may be needed by the Electronic Maintenance Department to bring personnel from the field to Ft Gordon to participate in the Critical Task Site Selection Board.

b. Support required from outside agencies:

(1) DOTD, participate in the Critical Task Site Selection Board process. Provide assistance in performing the Training Needs Assessment and preparing the training impact worksheets.

(2) DCD, provide computer retrieval support for the required TEP 14 runs. Review the proposal for BOIP and TOE impact.

(3) Electronic Maintenance Department, provide necessary SMEs to perform the analysis for the study and prepare the action for submission to SSC-NCR.

(4) OCOS, provide assistance to the SMEs and if necessary develop the SGA.

12. Administration:

a. Milestone schedules for each phase of analysis will be developed once the SMEs have been identified and are available for briefing and instruction on the AR 611-1 process.

b. An overall list of personnel involved with the study will be prepared once individuals have been identified.

c. Current Project Officer is: Alexander J. Loungeway
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WORKING PAPER FG90-201

TEST AND EVALUATION OF THE MILITARY OCCUPATIONAL SPECIALITY (MOS) EQUIPMENT EVALUATION FORM

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TABLE OF CONTENTS

TEST AND EVALUATION OF THE MILITARY OCCUPATIONAL SPECIALTY (MOS) EQUIPMENT EVALUATION FORM

INTRODUCTION

The Office of the Chief of Signal (OCOS) at the U.S. Army Signal Center and Fort Gordon is considering the merger of two maintainer Military Occupational Specialties (MOSs): 39L (Field Artillery Digital Systems Repairer) and 39Y (Field Artillery Tactical Fire Direction Systems (TACFIRE) Repairer). Possibly, after that merger, the merged MOS may become an Additional Skill Identifier (ASI) position under the 29J (Telecommunications Terminal Repairer, formerly Teletypewriter Equipment Repairer). These mergers are being considered because there are few soldiers in both the 39L and 39Y MOSs (approximately 100 soldiers in each), thus providing limited promotion opportunities and causing soldiers to attrite from these MOSs faster than they are entering. Consequently, adequate maintenance support for TACFIRE is seriously threatened. The 29J is a candidate MOS because these soldiers are becoming responsible for new equipments comparable to those curently maintained by the 39L and the future Advanced Field Artillery Tactical Data System (AFATDS) to be maintained by the 39Y. In addition, the 29J, comprised of approximately 2000 soldiers, will provide significantly greater promotion opportunities for the two 39 MOSs.

In March 1989 the first version of the equipment evaluation forms were given to Fort Stewart 39L and 39Y soldiers. These initial forms addressed various aspects of training issues, the completeness of the equipment lists, and the frequency and duration of repairs. (See Army Research Institute (ARI) Working Paper 39L and 39Y Merger Action: Inputs to Development of a Training Strategy, Finley and Shipman, 1989, for a complete overview). The present forms, which concentrated on organizational placement, technology comprising the equipment, and equipment functions, were administered to a 39L and 39Y Subject Matter Expert (SME), and to a 29J SME. Both forms gathered diagnostic and repair action information on the equipment maintained by the MOSs.

This equipment evaluation was undertaken to determine similarities and differences among the three MOSs' equipments. When MOSs are merged, the new MOS often is responsible for a greater number of equipments and, consequently, performance of more tasks. Issues to be considered include: whether the merger will impact on MOS aptitude requirements, training costs, training strategies, and sustainment training requirements. This report discusses opinions regarding equipment domain issues which could be useful as inputs to the proponent's MOS

structuring decisions as well as to the development of an effective training strategy. This paper will present the methods used to gather the opinions, the findings, a comparison of the Fort Stewart findings with the present evaluation, and an evaluation of the data collection form.

METHOD

Evaluation forms were developed to address equipment specific issues to aid in decision making regarding the possible merger. The forms focused on dimensions such as equipment technology, diagnostic and repair actions, and organizational placement of the equipment.

One SME was interviewed for the 29J MOS at Fort Gordon during the summer of 1989. One other SME was interviewed for both the 39L and 39Y MOSs, as he had been an instructor for both courses and was the only SME locally available. The Equipment Evaluation Form appears in Appendix A. The same format was used for all three MOSs but certain items were modified to be MOS equipment specific when appropriate.

When the evaluation form was administered to the 29J SME, questions 6 and 7, concerning the difficulty of diagnostic and repair actions, were asked so that he rated each equipment piece globally. It was decided that, due to equipment complexity and diversity of functions, the equipment piece should be subdivided into components (using the Maintenance Allocation Chart (MAC Chart)) in order to discern diagnostic and repair differences within each piece. These specific questions were administered again to the 29J SME; however, he still rated each piece globally as he stated that no information would be lost by rating in this manner. The 39L and 39Y SME received the revised component version of the evaluation form and rated those equipments by component. In the case of the 39L and 39Y equipments, the components did receive differential ratings.

An intermediate level summary of the data for the three MOSs is presented in Appendix B. A higher level summary is found in Appendix C.

FINDINGS

The SMEs rated the probability that the soldiers would perform in combat operations as 100% for all three MOSs. All the equipment in both the 39L and 39Y inventories would be employed in combat operations. For the 29J, with the exception of two equipment pieces, every piece was rated with a 100% combat use probability.

The next set of questions addressed the organizational placement of the MOSs and their equipments. The 29J equipment and personnel are located throughout the Army, from company to division levels. The 39L equipment is found at lower levels: either section, platoon, or battery. (Except for the Meteorological Computer, which is located at division level). The 39L soldiers are found at battalion level, with the exception of the Meteorological Computer repairer, who is also located at division level. The 39Y equipment is located from battalion to corps level; all the soldiers are found at battalion level.

Approximately 50% of the 29J equipment is repaired up to the general support level by the 29J soldier. About 30% is maintained to the direct support level, with contractor maintenance at the general support level. One equipment piece is maintained to the depot level. The AN/TYQ-33, Tactical Army Combat Service Support Computer System (TACCS), is maintained by the contractor with Army maintenance at unit level only. The LOGMARS(T) equipment piece is completely contractor maintained. For both the 39L and 39Y MOSs, all equipment is maintained by the soldiers to the direct support level.

The 29J equipment, for the most part, is used to receive and transmit messages. The newer transmission devices have added functions; for example, the Communications Systems Control Element(CSCE) VAX II computer is a communications system with a control element added. It serves a circuit planning function and plans, engineers, directs, and controls tactical communications from brigade level down.

The Battery Computer System (BCS) for the 39L MOS receives target description and location data from the Fire Direction System (TACFIRE). The operator then uses the BCS to convert this information to firing data for guns and rockets. The BCS keeps track of ammunition use, sends fire commands to the Gun Direction Units located at the guns or rockets, and also transmits messages through the modem to other subscribers. The Meteorological Computer provides weather information, such as wind direction, so that the guns will fire on target. The Data Display Group, Gun Direction Unit (GDU) allows the firing section to receive piece data and firing commands from the BCS at the TACFIRE quickly and

accurately and sends the BCS the gun status as the mission progresses. The Digital Message Device (DMD) is used by forward observer fire support teams to format requests for artillery fire support teams information.

The TACFIRE for the 39Y MOS is an automated data processing system used to accomplish artillery fire planning, fire mission processing, and supporting tasks. The Message Entry Device, Variable Format (VFMED) is a remote message input, display, and printing device. Digital messages are received, displayed, composed, and transmitted. (For a more detailed description of equipment functions, refer to question 4 in Appendix B).

The next question concerned the technology comprising the equipment piece. For the 29J MOS, 70% of the equipment was rated as from 95 to 100% electrical. (In rating the equipment as electrical, our SME meant that the equipment was predominately comprised of computer technology). The remaining 30%, which was the older equipment, was rated from 50 to 75% electrical, again, with electrical implying computer technology. For these equipments, as the inventory becomes modernized, the tendency is for a shift to more computer, and less mechanical, technology.

In the 39L, the GDU was rated 50% mechanical and 50% computerized. The DMD and the BCS were rated as 10% mechanical and 90% computerized. The Meteorological computer was rated as 100% computer technology. The SME stated that these equipments were of advanced modular replacement design.

For the 39Y MOS, the VFMED was rated as 50% mechanical and 50% digital computer boards. The Fire Direction Center (TACFIRE) was rated 15% mechanical, 25% analog-electrical, and 60% digital circuit boards. The TACFIRE is comprised of older, outmoded computer technology.

The next set of questions concerned the difficulty of diagnostic and repair actions. As was previously mentioned, the equipments were divided into component parts to assess diagnostic and repair difficulty differences within a particular equipment piece.

The 29J equipment was rated globally (one rating per equipment piece) because the SME stated that he believed that no information would be lost in rating in this manner. 36% of the equipment were rated from easy to moderate in diagnostic difficulty; the remaining 64% were rated from moderate to very difficult to diagnose.

The SME for the 39L and 39Y MOSs followed the component format when rating diagnostic difficulty; consequently, each piece will be described separately. In the 39L, 28% of the components in the BCS were rated as easy to diagnose, while the

remaining 72% were rated as moderate in diagnostic difficulty. The Meteorological Computer, rated globally, received a rating of 4; moderate in diagnostic difficulty. 94% of the components of the GDU were rated from extremely easy to relatively easy; only one component received a rating of moderate difficulty. For the DMD, 66% were rated easy in diagnostic difficulty, 27% were rated moderate in diagnostic difficulty, and 6% (one component) was rated as slightly above moderate in difficulty.

For the 39Y the VFMED, rated globally, received a moderate difficulty rating for diagnosis. For the TACFIRE system, 29% were rated as easy to diagnose, 66% were rated from moderate to fairly difficult to diagnose, and 6% were rated as extremely difficult to diagnose.

Regarding repair difficulty, for the 29J, the difficulty broke out as follows: for the LOGMARS(T) no repair actions are performed; for the CSCE VAXII the actions are variable, some are easy, while others are very hard. The remaining equipments (63%) were rated from moderate to very difficult to repair, with the newer computer systems receiving higher difficulty ratings..

For the 39L MOS, repair actions for all equipments (rated per component) varied from slightly below the midpoint in difficulty to slightly above. (For a more detailed analysis, refer to Appendix B). For the 39Y, all equipments were rated as difficult to repair.

The next question asked whether any job or memory aids/ were present for diagnostic tests or repair actions. In the 29J MOS 55% of the equipment rely on the troubleshooting charts in the Technical Manuals (TMs) as the sole job aid. 27% of the equipment pieces have some built-in diagnostics, while the remaining 18% is totally contractor maintained and job or memory aids are not an issue.

In the 39L MOS, 75% of the equipment have built-in diagnostic self tests. The TM is the sole aid used for the meteorological computer.

For the 39Y MOS the only available aid (other than the TMs) that the SME was aware of is a maintenance handbook printed by the school which condenses the more commonly used wiring diagrams. He also stated that approximately fifteen books and manuals must be taken to the field to repair the equipment properly. Without all the books the repairer is paralyzed.

In the 29J MOS, 50% of the equipment is a 1-man lift and 17% is a 2-man lift. The TACCS computer can be lifted by 2-3 men; the AN/UYQ-30 is a 3-4 man lift. The vans would need a crane to

be lifted. Three-fourths of the 39L equipment can be lifted by one man; the remaining equipment (the BCS) is a 2-man lift. In contrast, all of the 39Y equipment is extremely heavy.

The next question concerned the need for the maintainer to possess any especially important mental processing requirements. In the 29J MOS, the SME stated that both the TAACS and the TCT computers require a "lot of memory work." For the 39Y MOS, the SME stated that the equipment was not user friendly, repairs and diagnostics could be very involved, and a lot of training was required to become proficient in this type of equipment repair. The soldier must also be able to read binary code and convert it to a decimal code to perform diagnostic actions. Other than basic electronics knowledge, and maintenance and repair skills, there are no exceptional mental processing skills required for the 39L soldier.

The SMEs were asked to rate the relative importance of psychomotor to mental processing requirements. In the 29J MOS, half of the equipment required equal amount of psychomotor and mental skills. The newer equipments, approximately 25%, required substantially more mental abilities than psychomotor. And 30% of the equipments could not be rated since they have not yet been fielded. In the 39L, 33% of the equipments required slightly more mental skills than psychomotor; the remaining equipments were equally divided between psychomotor and mental abilities. For the 39Y MOS all equipments required slightly more mental skills than psychomotor.

The SMEs agreed that the newer 29J equipments were similar in technology to the 39L equipments. The diagnostic and repair actions performed were also judged to be comparable. The TACFIRE equipments were composed of older generation computer technology and, consequently, were dissimilar to the newer computer equipments. Due to the difficulty of maintaining the TACFIRE system, it was deemed important for the soldier to be placed with the equipment and for him to receive adequate refresher training.

This study replicates the findings of the previous Ft. Stewart evaluation. For both diagnostic and repair actions, the overall job of the 39Y is considered more difficult than that of the 39L. As for equipment technology similarities between the 39L and 39Y equipments there was agreement that the newer equipments of the 39L were dissimilar to the older circuit card and wiring technology of the 39Y's TACFIRE system. Likewise, the Ft. Stewart SMEs stressed the need for sustainment training for the 39Y personnel. The experts in both studies agreed that the 39L and 39Y MOSs should be merged.

RECOMMENDATIONS

It is important in MOS structuring or restructuring actions that like equipments are placed in the same inventory covered by a maintainer MOS. For example, two equipment items may seem very similar in outward appearance yet extremely dissimilar in inner technology. Mistakes in matching personnel to equipments could be made if careful evaluation of inner technologies were not considered.

The question concerning the technology comprising the equipment piece brought into focus a problematic issue in structuring equiment domains. It became clear that different words were often used to describe the same type of system. A common language needs to be developed so that, when describing technologies that comprise the equipments, each person uses the same vocabulary.

Drawing tangible conclusions from this study about the differences and commonalities of the equipments was difficult. The problem is that adequate and useful definitive descripters for equipments have not yet been developed. The descripters, "electrical" versus "mechanical" are too gross to provide very useful information. The domains in comparing equipments need to be further refined so that differences and commonalities are explicit.

It appears that the component format used to evaluate equipment can be more useful than global ratings for complicated systems. Perhaps the forms could be further refined to discern time between failure for, especially, the more difficult components and time required to repair these failures. However, for the simpler systems the global rating may suffice. Since diagnostic and repair difficulty ratings were, for the most part, agreed upon between the two survey instruments, it appears that useful information can be gleaned from using this approach to compare maintainer MOSs.

REFERENCES

Finley, D. L., and Shipman, M. G. (1989). 39L and 39Y Merger Action: Inputs to a Training Strategy. (ARI Working Paper). Fort Gordon, Georgia: Army Research Institute Field Unit.

APPENDIX A
EQUIPMENT EVALUATION FORM

MOS 39L

EQUIPMENT Data Display Group, Gun Direction OD-144/GYK-29(V)

1. (a). What is the probability that this equipment piece will be used in combat operations?

0% ______ 50% ______ 100%

(b). What is the probability that this MOS will perform under combat conditions?

0% ______ 50% ______ 100%

2. Organizational Placement. Please check the levels at which this equipment is found and levels at which this MOS is located.

	Equipment Location	MOS Location
(a) squad	______	______
(b) platoon	______	______
(c) company	______	______
(d) battallion	______	______
(e) brigade	______	______
(f) division	______	______
(g) corps	______	______
(h) EAC	______	______

3. Please check the highest level of maintenance repair by this MOS (in your unit).

(a) organizational ______

(b) direct support ______

(c) general support ______

(d) depot ______

4. List Equipment function(s). Also, the technology by which it is accomplished. (For example, if the machine sends messages, is it done by means of electrical/mechanical, automated, optical, or mechanical equipment?)

5. Technologies comprising the overall Equipment. (Mechanical, Computer Chips or Boards, Optical, etc.) Express these as percentages which add up to 100%.

Technologies	Percent of Total
	100%

6. Difficulty of Diagnostic Action. Circle a value from 1 to 10, with 1 being extremely easy and 10 being extremely difficult. If difficult, which is defined as a rating of 7 or above, explain why it is difficult on the immediately following sheets. (For example, is it hard because of ambiguity in test results, complex component relationships, etc.)

aa. Data Display Group Gun Direction OD-144/GYK-29 (B4010000)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ab. Data Display, Gun Direction ID-2123/GYK-29 (B4010002)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ac. SCA Board No. 1 (B4010004)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ad. SCA Board No. 2 (B4010005)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ae. Housing Assembly, SCA (B4010170)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
af. Keyboard Assembly (B4010032)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]

ag. Data Display, Deflection/Evaluation ID-2124/GYK-29 (B4010039)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ah. Gun Assembly Board No. 1 (B4010007)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ai. Housing Assembly- CA (B4010026)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
aj. Front Panel Assembly (B4010026)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ak. Control Case, Data Display C-10327/GYK-29 (B4010001)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
al. Power Supply Unit Assembly (B4010178)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
am. Power Supply Unit Chassis Assembly (B4010174)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
an. Connector Plate Harness (B4010068)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ao. GDU Case Subassembly (B4010196)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ap. SCA PSU Cable (B4010085)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
aq. Cable Assemblies Power Electrical W34 (B4009398-2) W34A (B4009398-3)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ar. Cable Assembly, Special Purpose W33 (B4009399-1) w33a (b4009399-2)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]

7. Difficulty of Repair Action. Circle a value from 1 to 10, with 1 being extremely easy and 10 being extremely difficult. If difficult, which is defined as a rating of 7 or above, explain why it is difficult on the immediately following sheets. (For example, is it hard because of difficulty in reaching the faulty component, etc.)

aa. Data Display Group Gun Direction OD-144/GYK-29 (B4010000)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ab. Data Display, Gun Direction ID-2123/GYK-29 (B4010002)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ac. SCA Board No. 1 (B4010004)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ad. SCA Board No. 2 (B4010005)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ae. Housing Assembly, SCA (B4010170)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
af. Keyboard Assembly (B4010032)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ag. Data Display, Deflection/Evaluation ID-2124/GYK-29 (B4010039)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ah. Gun Assembly Board No. 1 (B4010007)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ai. Housing Assembly- CA (B4010026)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
aj. Front Panel Assembly (B4010026)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ak. Control Case, Data Display C-10327/GYK-29 (B4010001)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
al. Power Supply Unit Assembly (B4010178)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
am. Power Supply Unit Chassis Assembly (B4010174)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
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ao. GDU Case Subassembly (B4010196)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ap. SCA PSU Cable (B4010085)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
aq. Cable Assemblies Power Electrical W34 (B4009398-2) W34A (B4009398-3)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ar. Cable Assembly, Special Purpose W33 (B4009399-1) w33a (b4009399-2)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]

8. Please indicate presence of job or memory aid for:

(a) Diagnostic tests. If present, identify and indicate usefulness and adequacy.

(b) Repair actions. If present, identify and indicate usefulness and adequacy.

9. Please list and describe any especially important psychomotor requirements (e.g., strength, fine control, dexterity, etc.) for:

(a) diagnostic actions

(b) repair actions

10. Please list any especially important mental processing requirements (e.g., knowledge of facts or procedural steps, problem solving, overall system understanding, etc.) for:

(a) diagnostic actions

(b) repair actions

11. Rate relative importance of psychomotor requirements to mental processing requirements (For example, if they are about equal then rate psychomotor as 50% and mental processing as 50%).

APPENDIX B
DETAILED SUMMARY OF EQUIPMENT DATA ON 29J, 39L, AND 39Y

1. (a). What is the probability that this equipment piece will be used in combat operations?

<u>29J</u>

Every piece was rated as 100% except
AN/UXC-7 50-75%
LOGMARS(T) 50%

<u>39L</u>

Every piece was rated as 100%

<u>39Y</u>

Every piece was rated as 100%

(b). What is the probability that this MOS will perform under combat operations?

29J- 100%

39L- 100%

39Y- 100%

2. Organizational Placement. Please check the levels at which this equipment is found and levels at which this MOS is located.

(a). Equipment

<u>29J</u>

1.	AN/UXC-7 and AM/UGC-74A(V)3	company through corps
2.	LOGMARS(T)	battalion through division
3.	AN/GRC-142 and AN/UYQ-30(TCT)	company through division
4.	TT-76(*)-GGC, CSCE VAX II, and AN-TYQ-33(TACCS)	company through battalion
5.	AN/UGC-4 and AN/TSC-58	company through brigade

39L

1.	Battery Computer System AN/GYK-29	battery
2.	CL-192/GMD-1 and OL-192A/GMD-1 Meteorological Computer	division
3.	Data Display Group, Gun Direction OD-144/GYK-29(V)	section
4.	Digital Message Device AN-PSG-2A and AN-PSG-2B	section and platoon

39Y

1.	Message Entry Device, Variable Format	battalion through corps
2.	Fire Direction Center, Artillery BN	battalion
3.	Fire Direction Center, Artillery DIV	brigade through corps

(b). MOS location

29J

1.	AN/UXC-7 and AN/UGC-74A(V)3	company through corps
2.	LOGMARS(T) and AN/GRC-142	company through division
3.	CSCE VAX II	battalion
4.	TT-76(*)-GGC and AN/TYQ-33(TACCS)	company through battalion

39L

1.	Battery Computer System AN/GYK-29, Data Display Group, Gun Direction OD-144/GYK-29(V), and Digital Message Device AN/PSG-2A and AN/PSG-2B	battalion
2.	OL-192/GMD-1 and OL-192A/GMD-1 Meteorological Computer	division

39Y

1.	Message Entry Device, Variable Format, Fire Direction Center, Artillery BN, and Fire Direction Center, Artillery DIV	battalion

3. Please check the highest level of maintenance repair by this MOS (in your unit).

29J

1.	AN/UXC-7, AN/GRC-142, AN/UGC-4, AN/UGC-74A(V)3, AN/TSC-58, AN/UYQ-30	general support
2.	TT-76(*)/GGC	depot
3.	CSCE VAXII, AN/GYK-33, BGU, AN/UGC-144	direct support (contractor maintained at general support)
4.	AN/TYQ-33(TACCS)	military at unit level, contractor at general support
5.	LOGMARS(T)	contractor maintained

For both the 39L and 39Y all equipment is direct support.

4. List Equipment functions. Also, the technology by which it is accomplished. (For example, if the machine sends messages, is it done by means of electrical/mechanical, automated, optical, or mechanical equipment?)

29J

AN/UXC-7: Enables electronic transfer of text or graphic information between both remote and centralized military communications facilities. Means-Electrical/Electronic Circuits.

LOGMARS(T): Optical scanner and bar code reader which interfaces with TACCS-3 computer.

AN/GRC-142: Receives and transmits ssb, cw, and compatible am signals. Consists of two subsystems (radio and hy portions). Radio subsystem includes amplifier, RT-662/GRC, whip or doublet antenna.

TT-76(*)/GRC: Sends and receives over direct current (dc) wirelines carrier, or radio systems when used with

Telegraph Terminal TH-5/TG, or similar line terminating devices.

AN/UGC-4: Sends and receives over direct current (dc) wirelines carrier, or radio systems. (The UGC-4 and the TT-76 are the same, except the 76 uses tape and the 4 uses pages).

AN/UGC-74(V)3: Provides a full duplex, asynchronous (ASCII or Baudot) communications capability with MIL-STD-188D and normal input keying (NIK) interfaces.

AN/TSC-58: Air or vehicular transportable assemblage that serves as a voice-frquency, cryptographic telegraph terminal. Contains facilities for 3 Voice-frequency (vf) full-duplex or 6 vf half-duplex circuits in either secure or non-secure nodes.

AN/TYQ-33(V): A small portable computer. Used to process data in the field. Used for Combat Service Support (CSS) missions; such as supply, maintenance, and personnel. Used for data transfer and to establish nets.
CSCE Vax II: A communications system with a control element. A van. Circuit planning - complete from brigade level down. Plans, engineers, directs, and control tactical communications.

AN/UYQ-30: Tactical computer capable of processing data over pair of wires. Line plotter computer.

BGU: Generates electronic CEOI.(communications, electronic, operations, instructions). Used in conjunction with an electronic notebook.

AN/UGC-144: A communications terminal. Videodisplay unit on top with a separate printer, keyboard, and a removable magnetic top.(Similar to AN/UGC-74 will replace the TT-(76).

<u>39L</u>

Battery Computer System AN/GYK-29: Receives target description and location from FDC by either wire or radio. Operator uses BSC to convert this information to firing data for guns or rockets. BCS will store incoming messages for review. Keeps track of ammunition use and sends fire commands to the 6 GDUs located at guns or rockets. BCU will also transmit messages through the modem to other subscribers.

OL-192/GMD-1 and OL-192A/GMD-1: Provides weather information, wind direction, etc. so that the guns will fire on target.

Data Display Group, Gun Direction OD-144/GYK-29(V): The GDU allows the firing section to receive piece data and firing commands from the BCU at the FDC quickly and accurately and sends the BCU the gun status as the mission progresses. The GDU is designed to operate in the self-propelled 155mm and 8-inch weapons and the towed 105mm weapons.

Digital Message Device AN/PSG-2A and AN/PSG-2B: Used by forward observers (FO) fire support teams to format requests for artillery fire support teams information. Standard message formats are completed by the FO. The DMD converts these messages to FSK signsals and is transmitted rapidly with standard military radio PRC 77.

39Y

Message Entry Device, Variable Format: The VFMED is a remote message input, display, and printing device. Digital messages are received, displayed, composed, and transmitted.

Fire Direction Center, Artillery OA-8389/GSG-10(V) 586452 BN and Fire Direction Center, Artillery OA-8390/GSG-10(V) 586542 DIV: The Corps or DivArty FCE is a subsystem of the Tactical Fire Direction System (TACFIRE), an automated data processing system used to accomplish artillery fire planning, fire mission processing, and supporting tasks. The difference between the two systems is the OA-8389/GSG-10(V) has one less MCMU (Mass Core Memory Unit), MTU (Magnetic Tape Unit), DDT (Digital Data Terminals) and is not equipped with an ETD (Electronic Tactical Display) and is capable of being housed in 1 S280 shelter.

5. Technologies comprising the overall equipment. (Mechanical, Computer Chips or Boards, Optical, etc.) Express these as percentages which add up to 100%.

29J

AN/UGC-4	50% Mechanical, 50% Electrical
AN/UXC-7 and AN/UGC-74A(V)3	25% Mechanical, 75% Electrical
AN/GYK-33	5% Mechanical, 95% Electrical

LOGMARS(T), AN/TYQ-33 (TACCS), CSCE VAX II, AN/UYQ-30 (TCT), TT-76(*)/GGC	2% Mechanical, 98% Electrical
AN/GRC-142	100% Electro-Mechanical

39L

Data Display Group, Gun Direction OD-144/GYK-29(V)	50% Mechanical,50% Circuit Boards
Digital Message Device AN/PSG-2A and AN/PSG-28 and Battery Computer System AN/GYK-29	10% Mechanical, 90% CKT Board
OL-192/GMD-1 and OL-192A/GMD-1	100% Computer Chips

39Y

Message Entry Device, Variable Format AN/GSC-21 (VFMED)	50% Mechanical-Analog, 50% CKT Boards-Digital
Fire Direction Center, Artillery OA-8389 BN	15% Mechanical (DPM, ELP) 25% CRT's, Power Supplies (Analog, Electrical) 60% CKT Boards (Digital)
Fire Direction Center, Artillery OA-8390 DIV	15% Mechanical (DPM, ELP) 60% CKT Boards (Digital) 25% CRT's, Power Supplies (Analog, Electrical)

6. Difficulty of Diagnostic Action. Circle a value from 1 to 10, with 1 being extremely easy and 10 being extremely difficult. If difficult, which is defined as a rating of 7 or above, explain why it is difficult on the immediately sheets. (For example, is it hard because of ambiguity in test results, complex component relationships, etc.)

29J

1. AN/TYQ-33 (TACCS)	2
2. AN/GYK-33	2-3
3. LOGMARS(T)	2-5

4.	AN/TSC-58	5
5.	AN/UXC-7, TT-76(*)/GGC, AN/UGC-4, AN/UGC-74A(V)3, CSCE VAX II	5-7
6.	AN/GRC-142	5-8
7.	AN/UYQ-30 (TCT)	5-9

<u>39L</u>

1.	Battery Computer System AN/GYK-29. Every component was rated the same. aa-am.	5
	The rest of the components are part of the GDU OD-144/GYK-29(V)	
an.	Connector Plate Harness	1
ao.	GDU Case Subassembly	1
ar.	Cable Assembly, Special Purpose	1
ap.	SCA PSU Cable	2
aq.	Cable Assemblies Power Electrical	2
2.	OL-192/GMD-1 and OL-192A/GMD-1	4
3.	Data Display Group, Gun Direction OD-144/GYK-29(V)	
ae.	Housing Assembly, SCA	1
ai.	Housing Assembly-CA	1
aj.	Front Panel Assembly	1
ak.	Control Case, Data Display	1
an.	Connector Plate Harness	1
ao.	GDU Case Subassembly	1
ap.	SCA PSU Cable	1
aq.	Cable Assemblies Power Electrical	1
ar.	Cable Assembly, Special Purpose	1
ab.	Data Display, Gun Direction ID-2123/GYK-29	3
ac.	SCA Board No. 1	3
ad.	SCA Board No. 2	3
af.	Keyboard Assembly	3
ag.	Data Display, Deflection/Evaluation ID-2124/GYK-29	3
ah.	Gun Assembly Board No. 1	3
al.	Power Supply Unit Assembly	3
am.	Power Supply Unit Chassis Assembly	3
aa.	Data Display Group Gun Direction OD-144/GKY-29	6

3. Digital Message Device AN/PSG-2A and AN/PSG-2B

ag. Front Housing Assembly	1
aj. Front Housing	3
ak. Power Supply Assembly	3
al. Preprocessor Assembly	3
am. Processor Assembly	3
an. Memory	3
ao. Interconnect Assembly	3
ap. Case Assembly	3
aq. Electronic Components Assembly	3
ar. Analog Interface Assembly	3
as. Housing, Rear	3
at. Interconnect Cables	3
ab. Display Keyboard Assembly	5
ac. Display Keyboard Circuit Card Assembly	5
ad. Display Driver and Display Panel Assembly	5
ae. Display Driver Assembly	5
af. Display Panel Assembly	5
aa. Digital Message Device AN/PSG-2A	6

<u>39Y</u>

1. Message Entry Device, Variable Format AN/GSC-21

aa.-am were all rated as 4.

2. Fire Direction Center, Artillery OA-8389 BN

ai. Headset H-144/U	1
an. Computer Digital AN/GYK-12(V)2	2
aj. Terminal Box J-3321/GSG-10	3
ak. Terminal Box 590149	3
al. Intercon Kit, Arty, Proc & Disp MK-1130	3
ay. Monitor, Remote Comm	3
ah. Junction Box 588583	5
am. Test Set, Module	5
ar. Control, Magnetic Tape Unit	5
aw. Console, Arty Control	5
as. Converter Group, Power	6
ao. Control Processing Unit MX-8950/ GYK 586320	7
ap. Input/Output Unit MX-8951/GYK 586320	7
aq. Memory Unit, Mass Core MU-619/ GYK 586320	7

au.	Display Unit, Digital Plotting	7
av.	Line Printer, Electronic	7
ax.	Control, Communications C-9901	7
au.	Display Unit, Digital Plotting	7
av.	Line Printer, Electronic	7
ax.	Control, Communications C-9901	7
aa.	Fire Direction Center, Artillery Proc & Disp	10

7. Difficulty of Repair Action. Circle a value from 1 to 10, with 1 being extremely easy and 10 being extremely difficult. If difficult, which is defined as a rating of 7 or above, explain why it is difficult on the immediately following sheets. (For example, is it hard

29J

LOGMARS(T)	No repair actions performed
CSCE VAX II	Variable (Some very hard and some easy).
AN/GYK-33	2-3
AN/TSC-58	5
AN/UXC-7	5-7
TT-76(*)/GGC	5-7
AN/UXC-4	5-7
AN/UGC-74A(V)3	5-7
AN/GRC-142	5-8
AN/UYQ-30 (TCT)	5-9
AN-TYQ-33 (TACCS)	8

39L

1. Battery Computer System AN/GYK-29

ac.-ar.	4
aa. Data Display Group Gun Direction OD-144/GYK-29	6
ab. Data Display, Gun Direction ID-2123/GYK-29	6

2. OL-192/GMD-1 and OL-192A/GMD-1 (Meteorlogical Computer)

aa.-ar.	3

3. Data Display Group, Gun Direction
OD-144/GYK-29(V) GDU (Part of BCS)

ab.-ar. (replace actions)	4
aa. Data Display Group, Gun Direction	6

4. Digital Message Device AN/PSG-2A
and AN/PSG-2B

aa.-ar. (replace actions)	4

<u>39Y</u>

VFMED	6
FDC, Artillery BN	7

8. (a). Please indicate the presence of job or memory aids for diagnostic tests.

<u>29J</u>

1.	AN/UXC-7	Diagnostic tests in TM
2.	AN/GRC-142	Troubleshooting Charts in TM
3.	TT-76(*)/GGC	Troubleshooting Charts in TM
4.	AN/UGC-4	Troubleshooting Charts in TM
5.	AN/UGC-74A(V)3	Troubleshooting Charts in TM
6.	AN/TSC-58	Troubleshooting Charts in TM
7.	LOGMARS(T)	Diagnostic tests come on screen with what is wrong.
8.	AN/TYQ-33 (TACCS)	Gives a failure code if something happens- built-in diagnosis. Also has a diagnostic floppy. Manuals have test runs.
9.	AN/UYQ-30 (TCT)	Failure codes on screen. (However, failure codes don't always isolate the problem). Chart in book to run tests.
10.	AN/GYK-33	Contractor has an operator's manual, government doesn't have any type of repair manual.
11.	CSCE VAX II	Don't know yet.

<u>39L</u>

1.	Battery Computer System Digital Message Device	Certain diagnostic tests can be run.

2.	OL-192 Meteorological Computer	TMs. Not hard to fix.
3.	Data Display Group, Gun Direction.	Possesses some built-in self-tests. Fair. 80% of the time the diagnostic self-tests will be correct.

<u>39Y</u>

1. Message Entry Device, Variable Format VFMED
2. Fire Direction Center, Artillery BN
3. Fire Direction Center, Artillery DIV

There is a maintenance handbook printed by the school which condenses the more commonly used diagrams for wiring.

(b). Please indicate presence of job or memory aid for repair actions.

<u>29J</u>

All equipment use TMs for repair actions.

<u>39L</u>

Battery Computer System	User friendly

OL-192 Meteorological Computer

Data Display Group, Gun Direction

Digital Message Device

<u>39Y</u>

Message Entry Device, Variable Format VFMED

Fire Direction Center, Artillery BN

Fire Direction Center, Artillery DIV

9. (a). Please list and describe any especially important psychomotor requirements (e.g., strength, fine control, dexterity, etc.) for:

<u>29J</u>

1. AN/UXC-7	1 man lift
2. LOGMARS(T)	1 man lift
3. AN/GRC-142	1 man lift
4. AN/GYK-33	1 man lift
5. BGU	1 man lift
6. AN/GYK-33	1 man lift
7. AN/UGC-74A(V)3	2 man lift
8. AN/UGC-144	2 man lift
9. AN/TYQ-33 (TACCS)	2 and 3 man lift
10. AN/UYQ-30	3 and 4 man lift
11. TT-76(*)/GGC	lift with a crane
12. AN/TSC-58	lift with a crane

<u>39L</u>

1. OL-192 Meteorological Computer	1 man lift
2. Data Display Group, Gun Direction	1 man lift
3. Battery Computer System	2 man lift
4. Digital Message Device	1 man lift

<u>39Y</u>

1. Message Entry Device, Variable Format	heavy equipment
2. Fire Direction Center, Artillery BN	heavy equipment
3. Fire Direction Center, Artillery DIV	heavy equipment

10. Please list any especially important mental processing requirements. (e.g., knowledge of facts or procedural steps, problem solving, overall system understanding, etc.)

29J

Diagnostic Actions	
AN/TYQ-33 (TACCS)	requires a lot of memory work
AN/UYQ-30 (TCT)	requires a lot of memory work

39Y

1. Message Entry Device, Variable Format VFMED

2. Fire Direction Center, Artillery BN

3. Fire Direction Center, Artillery DIV

Not user friendly, lot of training, very involved.

11. Rate relative importance of psychomotor requirements to mental processing requirements. (For example, if they are about equal then rate psychomotor as 50% and mental processing as 50%).

29J

(Psychomotor listed first)	
1. LOGMARS(T)	15/85
2. AN/TYQ-33 (TACCS)	25/75
3. AN/UYQ-30 (TCT)	25/75
4. AN/UXC-7	50/50
5. AN/GRC-142	50/50
6. TT-76(*)/GGC	50/50
7. AN/UGC-4	50/50
8. AN/UGC-74A(V)3	50/50
9. AN/TSC-58	50/50
10. CSCE VAC II	Don't know yet
11. AN/GYK-33	Don't know yet
12. BGU	Don't know yet
13. AN/UGC-144	Don't know yet

39L (Psychomotor listed first)

1. Battery Computer System	40/60
2. OL-192 Meteorological Computer	50/50
3. Data Display Group, Gun Direction	50/50
4. Digital Message Device	50/50

39Y (Psychomotor listed first)

1.	Message Entry Device, Variable Format (VFMED)	40/60
2.	Fire Direction Center, Artillery BN	40/60
3.	Fire Direction Center, Artillery DIV	40/60

APPENDIX C
HIGHER LEVEL SUMMARY OF EQUIPMENT DATA ON 29J, 39L, AND 39Y

1. (a). What is the probability that this equipment piece will be used in combat operations?

29J

Every piece was rated as 100% except:

AN/UXC-7	50-75%
LOGMARS(T)	50%

39L

Every piece was rated as 100%

39Y

Every piece was rated as 100%

For all practical purposes, it would probably be safe to say that all are 100%.

(b). What is the probability that this MOS will perform under combat operations?

All three MOSs were rated as 100%.

2. Organizational Placement.

(a). Equipment

29J

The equipment is located throughout from company level to division level.

39L

The equipment is located at a low level (section, platoon, and battery) except the Meteorological Computer which is located at the division level.

39Y

It is all located at a high level. (battalion through corps level).

(b). MOS location

29J

The MOS is located throughout from company through division levels.

39L

The MOS is located at levels battalion-division.

39Y

The MOS is located at battalion level.

3. Please check the highest level of maintenance repair by this MOS. (in your unit).

29J

1.	AN/UXC-7, AN/GRC-142, AN/UGC-4, AN/UGC-74A(V)3, AN/TSC-58, AN/UYQ-30	general support
2.	TT-76(*)/GGC	depot
3.	CSCE VAXII, AN/GYK-33, BGU, AN/UGC-144	direct support (contractor maintained at general support)
4.	AN/TYQ-33(TACCS)	military at unit level, contractor at general support
5.	LOGMARS(T)	contractor maintained

For both 39L and 39Y all equipment is direct support.

4. List Equipment functions. Also, the technology by which it is accomplished. (For example, if the machine sends messages, is it done by means of electrical/mechanical, automated, optical, or mechanical equipment?)

29J

AN/UXC-7: Enables electronic transfer of text or graphic information between both remote and centralized military communications facilities. Means-Electrical/Electronic Circuits.

LOGMARS(T): Optical scanner and bar code reader which interfaces with TACCS-3 computer.

AN/GRC-142: Receives and transmits ssb, cw, and compatible am signals. Consists of two subsystems (radio and hy portions). Radio subsystem includes amplifier, RT-662/GRC, whip or doublet antenna.

TT-76(*)/GRC: Sends and receives over direct current (dc) wirelines carrier, or radio systems when used with Telegraph Terminal TH-5/TG, or similar line terminating devices.

AN/UGC-4: Sends and receives over direct current (dc) wirelines carrier, or radio systems. (The UGC-4 and the TT-76 are the same, except the 76 uses tape and the 4 uses pages).

AN/UGC-74(V)3: Provides a full duplex, asynchronous (ASCII or Baudot) communications capability with MIL-STD-188D and normal input keying (NIK) interfaces.

AN/TSC-58: Air or vehicular transportable assemblage that serves as a voice-frquency, cryptographic telegraph terminal. Contains facilities for 3 Voice-frequency (vf) full-duplex or 6 vf half-duplex circuits in either secure or non-secure nodes.

AN/TYQ-33(V): A small portable computer. Used to process data in the field. Used for Combat Service Support (CSS) missions; such as supply, maintenance, and personnel. Used for data transfer and to establish nets.

CSCE Vax II: A communications system with a control element. A van. Circuit planning - complete from brigade level down. Plans, engineers, directs, and control tactical communications.

AN/UYQ-30: Tactical computer capable of processing data over pair of wires. Line plotter computer.

BGU: Generate electronic CEOI.(communications, electronic, operations, instructions). Used in conjunction with an electronic notebook.

AN/UGC-144: A communications terminal. Videodisplay unit on top with a separate printer, keyboard, and a removable magnetic top.(Similar to AN/UGC-74 will replace the TT-(76).

39L

Battery Computer System AN/GYK-29: Receives target describing and location from FDC by either wire or radio. Operator uses BSC to convert this information to firing data for guns or rockets. BCS will stroe incoming messages for review. Keeps tracks of ammunition use and sends fire commands to the 6 GDUs located at guns or rockets. BCU will also transmit messages through the modem to other subscribers.

OL-192/GMD-1 and OL-192A/GMD-1: Provides weather information, wind direction, etc. so that the guns will fire onk target.

Data Display Group, Gun Direction OD-144/GYK-29(V): The GDU allows your firing section to receive piece data and firing commands from the BCU at the FDC quickly and accurately and sends the BCU your gun status as the mission progresses. The GDU is designed to operate in the self-propelled 155mm and 8-inch weapons and the towed 105mm weapons.

Digital Message Device AN/PSG-2A and AN/PSG-2B: Used by forward observers (FO) fire support teams to format requests for artillery fire support teams information. Standard message formats are completed by the FO. The DMD converts these messagesto FSK signsals and is transmitted rapidly with standard military radio PRC 77.

39Y

Message Entry Device, Variable Format: The VFMED is a remote message input, display, and printing device. Digital messages are received, displayed, composed, and transmitted.

Fire Direction Center, Artillery OA-8389/GSG-10(V) 586452 BN and Fire Direction Center, Artillery OA-8390/GSG-10(V) 586542 DIV: The Corps or DivArty FCE is a subsystem of the Tactical Fire Direction System (TACFIREO, an automated data processing system used to accomplish artillery fire planning, fire mission processing, and supporting tasks. The difference between the two systems is the OA-8389/GSG-10(V) has one less MCMU (Mass Core Memory Unit), MTU (Magnetic Tape Unit), DDT (Digital Data Terminals) and is not equipped with an ETD (Electronic Tactical Display) and is capable of being housed in 1 S280 shelter.

5. Technologies comprising the overall equipment.

<u>29J</u>

10% is 50% Mechanical, 50% Electrical

20% is 25% Mechanical, 75% Electrical

10% is 5% Mechanical, 95% Electrical

50% is 2% Mechanical, 98% Electrical

10% is 100% Electrical

<u>39L</u>

Data Display Group, Gun Direction OD-144/GYK-29(V)	50% Mechanical, 50% CKT Board
Digital Message Device AN/PSG-2A and AN/PSG-28 and Battery Computer System AN/GYK-29	10% Mechanical, 90% CKT Board
OL-192/GMD-1 and OL-192A/GMD-1	100% Computer Chips

<u>39Y</u>

Message Entry Device, Variable Format AN/GSC-21 (VFMED)	50% Mechanical-Analog, 50% CKT Boards-Digital
Fire Direction Center, Artillery OA-8389 BN	15% Mechanical (DPM, ELP) 25% CRT's, Power Supplies (Analog, Electrical) 60% CKT Boards (Digital)
Fire Direction Center, Artillery OJA-8390 DIV	15% Mechanical (DPM, ELP) 60% CKT Boards (Digital) 25% CRT's, Power Supplies (Analog, Electrical)

6. Difficulty of Diagnostic Action. 1 is extremely easy and 10 is extremely difficult.

<u>29J</u>

18% is rated as 2-3.
9% is rated as 2-5.
9% is rated as 5.

46% is rated as 5-7.
18% is rated as 5-9.

Almost 1/2 is rated between moderate and fairly difficult.

<u>39L</u>

1. Battery Computer System AN/GYK-29.
   17% is rated as 1.
   11% is rated as 2. (1-2 is 28%)
   72% is rated as 5.

Almost 3/4 is rated as moderate in difficulty.

2. OL-192 (Meteorological Computer)
Rated at 4.

3. Data Display Group, Gun Direction.
   50% is rated as 1.
   44% is rated as 3.
   6% is rated as 6. (One component).

Almost 95% of the diagnostic actions are rated from extremely easy to fairly easy.

4. Digital Message Device AN/PSG-2A
   6% is rated as 1. (One component).
   61% is rated as 3.
   27% is rated as 5.
   6% is rated as 6. (One component).

88% is rated from fairly easy to moderate in difficulty.

<u>39Y</u>

1. Message Entry Device, Variable Format AN/GSC-21
   100% were rated at 4.

2. Fire Direction Center, Artillery OA-8389 BN
   5% is rated as 1. (One component).
   5% is rated as 2. (One component).
   19% is rated as 3.
   19% is rated as 5.
   5% is rated as 6.
   42% is rated as 7.
   5% is rated as 10.
   66% is rated from 5-7.

7. Difficulty of Repair Action. (1 is extremely easy and 10 is extremely difficult).

29J

9% no repair actions performed. (LOGMARS(T)).
9% Variable. Some is very hard and some is easy. (VAX II).
36% is from 5-7.
18% is from 5-9. (These 2 combined is 54%).
9% is rated as 8.

About 55% is rated from moderate to very hard.

39L

1. Battery Computer System

89% is rated as 4.
11% is rated as 6.

2. OL-192 (Meteorological Computer).
Rated as 3.

3. Data Display Group, Gun Direction.
95% is rated as 4. (Just replace actions, no repair.)
5% is rated as 6.

4. Digital Message Device AN/PSG-2A.
100% is rated as 4. (Replace actions only).

Most are moderate in repair difficulty.

8. (a). Please indicate the presence of job or memory aids for diagnostic tests.

29J

55% are the troubleshooting charts in the TMs only.
27% have built-in diagnostics.
18% are contractor maintained.

39L

75% have diagnostic self-tests.
The TMs are used for the Meteorological Computer.

39Y
No information.

(b). Please indicate presence of job or memory aid for repair actions.

29J

All equipment use TMs for repair actions.

9. (a). Please list and describe any especially important psychomotor requirements (e.g., strength, fine control, dexterity, etc.) for:

29J

50% is a 1-man lift.
17% is a 2-man lift.

8% is a 2-3 man lift. (One component).
8% is a 3-4 man lift. (One component).
17% is lift with a crane.

39L

75% is a 1-man lift.
25% is a 2-man lift.

39Y

All equipment is heavy.

10. Please list any especially important mental processing requirements. (e.g., knowledge of facts or procedural steps, problem solving, overall system understanding, etc.)

29J

Diagnostic Actions
Both the AN/TYQ-33(TACCS) and the AN/TYQ-30(TCT) require a lot of memory work.

39Y

All the equipment is not user-friendly, a lot of training is required, very involved.

11. Rate relative importance of psychomotor requirements to mental processing requirements. (For example, if they are about equal, then rate psychomotor as 50% and mental processing as 50%).

Psychomotor is rated first.

<u>29J</u>

8% is rated 15/85 (One component).
15% is rated 25/75.
46% is rated 50/50.
31% is rated as "Don't know yet."

<u>39L</u>

33% is rated as 40/60.
66% is rated as 50/50.

<u>39Y</u>

All equipment is rated 40/60.

WORKING PAPER FG 91-02

ANALYSIS OF THE ATTRITION OF THE MILITARY OCCUPATIONAL SPECIALTY (MOS) SPECIAL ELECTRONIC DEVICES REPAIRER (39E) STUDENTS

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CONTENTS

INTRODUCTION

The Army Research Institute (ARI) was requested by Office, Chief of Signal (OCOS) to investigate probable causes for the recurring high attrition rate in the Military Occupational Specialty (MOS) 39E (Special Electronic Devices Repairer) Advanced Individual Training (AIT) course. The attrition rate has been approximately thirty-five percent for Fiscal Years (FY) 1986, 1987, and 1988.

Attrition is defined as loss of a student who enrolls in a course of instruction but does not graduate. There are two types of attrition, academic and administrative. Academic attrition is defined as loss of a student from the course because of the student's demonstrated inability to achieve the course objectives. This type of attrition includes codes for comprehension, physical, motivational, leadership skills, and English language comprehension. Administrative attrition is defined as loss of a student from the course by administrative action for reasons totally independent of the student's ability to complete course objectives. Codes include Early Discharge Program, weight, erroneous enlistment, medical, disciplinary, compassionate, security, unit recall, erroneous enrollment, hospitalization, AWOL, desertion, and other.

The 39E soldier maintains a wide variety of equipment. Included are items such as: Night Vision Systems, Mine Detectors, Electronic Azimuth Determining Systems, and Nuclear, Biological, and Chemical (NBC) Warning and Measuring Systems. At the time of our evaluation, the length of the course was 28 weeks. The Basic Electronics Training (BET) portion of the course included nine modules and lasted 8.8 weeks; the MOS specific portion lasted 19.2 weeks.

An Armed Services Vocational Aptitude Battery (ASVAB) Electronics (EL) score of 95 is required for admission to the 39E MOS; the lowest score required for any maintenance MOS in the Signal Corps. To investigate the possibility that lower verbal ability could be a contributing factor to the high attrition rate, the Surveillance Communication (SC) scores, which contain a verbal subtest that the EL score lacks, were also examined. The objective of this research was to determine if there is a relationship between EL and SC scores and attrition rate.

METHOD

Previous attrition analyses conducted by the Training Department and records collected from the Department of Evaluation and Standardization (DOES), OCOS, Student Records, and the Communication Electronics (CE) Maintenance Department were examined. The TRADOC Army Information Management System (TAIMS) data base was utilized to download student Personnel Records for FY 1989.

Academic and administrative attrition were combined for the purpose of this evaluation. As a rule, and, in this case, administrative attrition normally runs two to three percent for all classes. Therefore, variance in total attrition is produced from academic failure.

Students who were turned back to a following class were counted only once. Students beginning in a 1989 class were included, even if they did not graduate until 1990, providing that the class had graduated and their final course scores were available at the time of the analysis.

The mean EL and SC scores were calculated for the group that failed the course and for the group that graduated. T-tests were used to determine if the two groups differed significantly on these two scores. The relationships of the EL and SC scores to graduation from this course were also determined.

RESULTS & DISCUSSION

Fourteen classes, with a total enrollment of 201 students, were examined. Complete information was available on one hundred and fifty students, therefore, only those files were used in the analyses. For our 1989 sample, we calculated a 27% attrition rate.

The mean (M) and standard deviation (SD) were computed for the EL and SC scores for the two (pass/fail) student groups. The data are presented in Table 1.

Table 1

Mean Scores of Student Groups

	Group	
	Passed	Failed
EL Score		
M	109.5	101.0
SD	10.8	5.6
SC Score		
M	107.6	100.8
SD	13.4	10.4

T-tests were performed to determine if the two groups differed significantly on these two scores. The EL score for the attrited group was significantly lower than the score for the group that graduated $t(133)= -6.28$, $p<.0001$. The SC score for the attrited group was also significantly lower than for the group that graduated $t(148)= -2.92$, $p<.004$.

The Point Biserial Correlation (ASVAB score vs. Pass/Fail) revealed a relationship between EL score and passing the course; $r(150)=.37$, $p<.0001$. The correlation between SC score and successfully completing the course was $r(150)= .23$, $p<.004$.

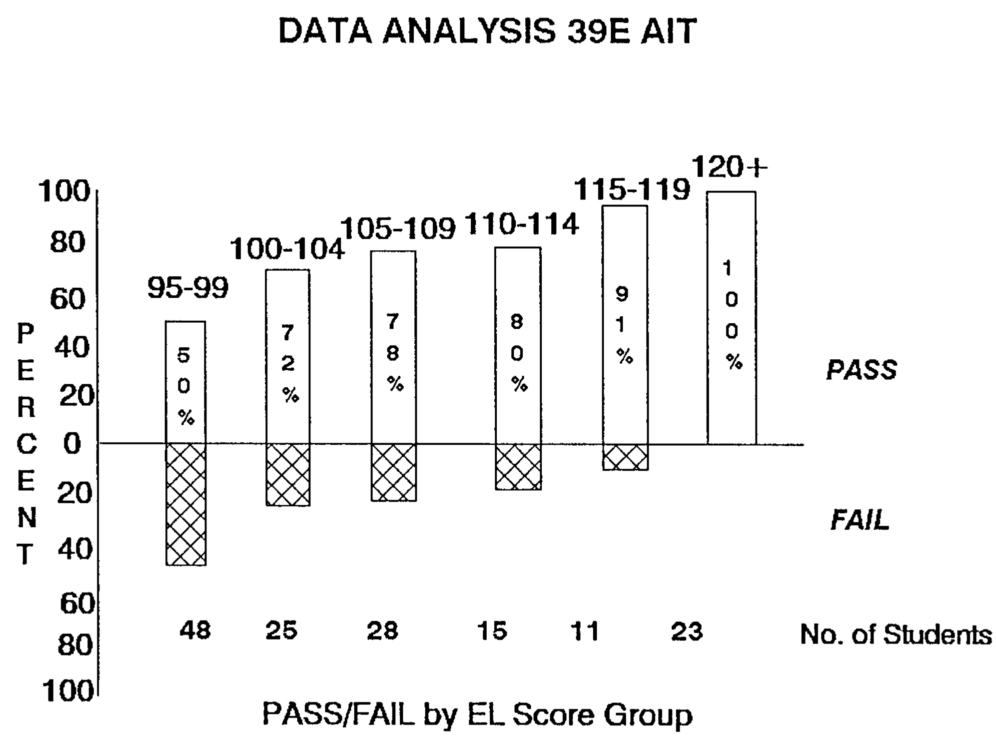
Because group differences were demonstrated, the following summary analyses were performed. The EL scores for the students were grouped into intervals of five and the frequency of students who passed or failed in each interval were computed. These figures were converted into percentages of students for each interval who either passed or failed. These data are presented numerically in Table 2 and graphically in Figure 1.

Table 2

Student Pass/Fail Rate By EL Interval

EL Score Interval	Total Students	Number Passed	Number Failed	Percent Passed
95-99	48	24	24	50%
100-104	25	18	7	72%
105-109	28	22	6	78%
110-114	15	12	3	80%
115-119	11	10	1	91%
120- +	23	23	0	100%

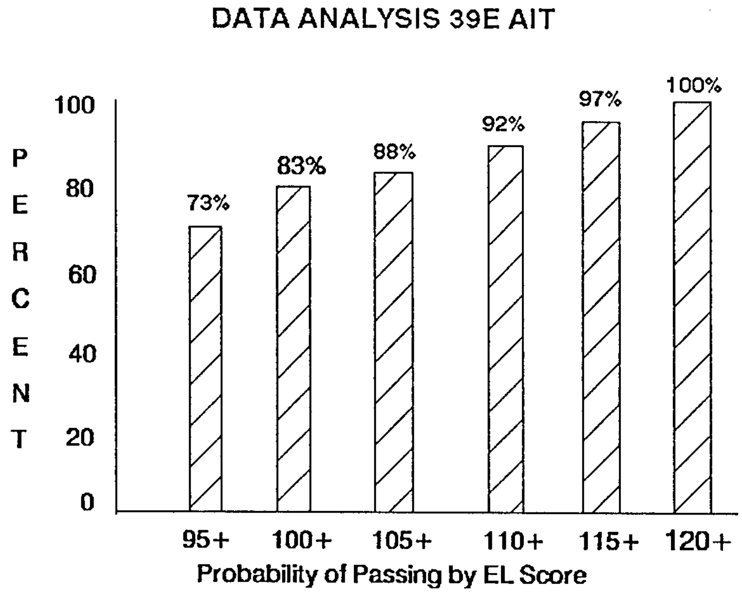
Figure 1



For example, in the 95-99 EL score interval, containing 48 students, 24 passed and 24 failed. In other words, for every student that successfully completed training, another student failed. In the 100-104 score range, containing 25 students, 18 passed and 7 failed. This translated into a 72% pass rate for students in this interval. Successive intervals can be interpreted similarly.

The probabilities of passing the course based on the cumulative EL interval were calculated. These data are presented in Figure 2.

Figure 2
Probability of Passing by EL Interval



The interval EL data were converted into cumulative form presenting the percent of the total students contained within each interval as well as the percent of the total attrition that interval contains. These data are presented in Table 3.

Table 3

Percentage Of Attrition By EL Interval

EL Score Interval	% of Total Students	% of Total Attrition
95-99	39%	60%
95-104	59%	76%
95-109	70%	90%
95-114	80%	97%
95-119	85%	100%
95-120+	100%	-

This table demonstrates the cumulative effects as a cut score is raised in intervals of five points. For example, raising the cut score from 95 to 100 reduces the available student pool by 39%, but also reduces the attrition rate by 60%. A closer examination of this table shows, at each successive increase in the cut score, the marginal percentage gain made in attrition reduction is less than the decrease in the available student pool.

SUMMARY

This research effort has confirmed that the low EL entry requirement was a contributing factor in the historically high attrition rate experienced by the 39E MOS. The EL score could be raised to 100, which would provide the greatest attrition relief while eliminating the fewest potential students. This option makes sense from a statistical viewpoint but may be unacceptable from a practical, administrative viewpoint because it would result in approximately a 17% attrition rate. An alternate recommendation would be a cut score of 105, which would result in approximately a 12% attrition rate.

WORKING PAPER FG 91-04

DEVELOPING AN EQUIPMENT DOMAIN MODEL FOR USE IN MOS RESTRUCTURING

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The views, opinions, and findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation.

DEVELOPING AN EQUIPMENT DOMAIN MODEL FOR USE IN MOS RESTRUCTURING

EXECUTIVE SUMMARY

Research Requirements:

In 1988, the U.S. Army Signal School requested that the Army Research Institute (ARI) initiate a focused examination of MOS aggregation issues existing within the Army's Signal Branch. The ultimate objective of this effort is to develop and evaluate methods to facilitate the analysis and design of Military Occupational Specialties (MOSs) and Career Management Fields (CMFs) across the Army. This is part of a larger effort by ARI's Systems Research Laboratory to produce Manpower and Personnel Integration (MANPRINT) tools.

The purpose of this paper is to report the progress made to date in the examination of equipment domains as a vehicle for gaining a further understanding of equipment characteristics and as a principal component of effective MOS design. Past research has often focused on soldier characteristics including a multitude of job performance and job enrichment variables with an examination of the soldier's knowledge, skills, and abilities as they relate to the tasks the soldier is to perform. This information has greatly enhanced our understanding of the qualities the man brings to the man-system relationship but a full understanding of the attributes brought by the equipment system remains unclear. The purpose of the current effort is to concentrate on the equipment characteristics facet of the relationship and specifically on the determination of constructs called "equipment domains".

Procedure:

The work underlying this working paper is based on the concept of developing select aspects of an "Equipment Domain Methodology" to be used in MOS restructuring decisions. MOS restructuring involves revising the task composition of an MOS by eliminating tasks, adding tasks, merging tasks with another MOS, or creating an entirely new MOS. The priority of the present work focused on initiating the development of one aspect of this methodology, the Equipment Domain Model. This model addresses the creation of equipment domains and the methods employed to place related equipment items within domains. The model examines the strategies and processes involved in creating equipment domains that are functional in the determination of training requirements and MOS assignments. This Phase 1 effort specifically involved the development of research methodologies and the formulation of data collection procedures to support

and the formulation of data collection procedures to support these research methodologies.

Findings:

In the chapters of this working paper, documentation is provided to support the contention that items of equipment can be clustered into meaningful groups based on related or similar attribute profiles. The present effort was able to establish: 1) a working set of equipment-driven attributes, 2) data sources which provide values for those attributes, 3) potential strategies for domain assignment, and 4) methodologies to acquire and verify attribute profile data. The present effort establishes the feasibility of creating a functional Equipment Domain Model for inclusion in the Equipment Domain Methodology to be used in MOS restructuring.

Utilization of Findings:

The conclusions drawn from this Phase 1 effort serve as the foundation for future research efforts. In particular, future efforts are recommended that focus on the resolution of two issues related to 1) the need for data to create maintenance domains and 2) the determination of the appropriate level of indenture for equipment items. Solutions to these issues will allow for a more complete formulation of the Equipment Domain Model; additionally, these results are also required for the development of the other aspects of the Equipment Domain Methodology.

DEVELOPING AN EQUIPMENT DOMAIN MODEL FOR USE IN MOS RESTRUCTURING

CONTENTS

List of Tables

List of Figures

DEVELOPING AN EQUIPMENT DOMAIN MODEL FOR USE IN MOS RESTRUCTURING

Introduction

This report documents the concepts, procedures, and findings of an initial investigation into the feasibility of using equipment domains in the process of Military Occupational Specialty (MOS) restructuring. This investigation is one of several research efforts focusing on the development of methodologies and techniques which have potential use in effective MOS restructuring.

The purpose of this paper is to report the progress made to date in the examination of equipment domains as a vehicle for gaining a further understanding of equipment characteristics and as a principal component of effective MOS design. This paper represents the culmination of Phase 1 of this examination. The findings and conclusions of this effort will serve to guide future endeavors in the area of equipment domains.

Background

The Army is continually faced with critical decisions regarding the creation of effective MOS structures. Through the process of MOS restructuring, the Army is able to maintain a strategically balanced alignment of manpower and personnel despite revisions in doctrine, training, organizational structure, and the introduction of new equipment and technology. The burden of making these decisions falls on the combat developer, training developer, and personnel proponent.

An MOS represents an occupation performed by an Army enlisted soldier or warrant officer and may be characterized in essentially two ways: first, by the tasks that a trained, qualified soldier with the appropriate knowledge, skills and abilities is expected to perform in the accomplishment of a specific objective; and secondly, by the nature of the particular types of equipment items used for or critical to the successful performance of that same specific objective. This relationship between soldier and equipment with respect to job performance requirements must be addressed for effective MOS restructuring to occur.

Due to the complex issues of force modernization, there exists a critical need to further our technical understanding of the relationship between MOS design and equipment characteristics. Considerable research has been conducted on developing evaluation methodologies for soldier characteristics.

This research has focused on a multitude of job performance and job enrichment variables including the examination of the soldier's knowledge, skills, and abilities as they relate to the tasks the soldier is to perform. This information has greatly enhanced our understanding of the qualities the man brings to the man-system relationship but a full understanding of the attributes brought by the system remains unclear. This situation is further complicated by the fact that MOSs often operate or maintain more than one piece of equipment. It is therefore necessary to determine what subsets or clusters of equipment are reasonable for assignment of MOSs. The purpose of the current effort is to concentrate on the equipment characteristics facet of the man-system relationship and specifically on the determination of constructs called "equipment domains" as shown in Figure 1.

For the purposes of this investigation, an equipment domain is defined as a collection of equipment items which have been clustered based on their similarity on a set of equipment attributes. Equipment items having common characteristics based on these attributes are assigned to the same domain. Attributes refer to classes of equipment characteristics such as technology, function, and capabilities. Across a sample of equipment items, there may be various quantitative values or narrative descriptions for a given attribute. For example, there may be various types of technology, functions, or capabilities within a given set of equipment items.

The utility of equipment domains as a vehicle for improving the understanding of equipment characteristics is based on the premise that the recognition of similarities and differences of objects is the first step in organizing knowledge. The primary purpose of such an organization is to describe the structure and relationships of objects with regard to each other. Simplifying these relationships allow general statements to be made about classes of objects (Fleishman & Quaintance, 1984). From these general statements, criteria can be developed for the inclusion of additional items into a given class of objects. Thus, the inclusion criteria provide a meaningful description or definition of all items within the class of objects. Given that the class definition subsumes the individual descriptions of the objects contained within it, an economical vehicle for effective communication is provided. The summarized information is more easily managed and communicated than the component pieces of information.

As the Army moves toward force modernization within the context of current doctrine, effectively communicating between the diverse elements of the Manpower and Personnel Integration (MANPRINT) program is critical. The fundamental premise of MANPRINT is to influence the total system design early in the acquisition process and thus design equipment to maximize the

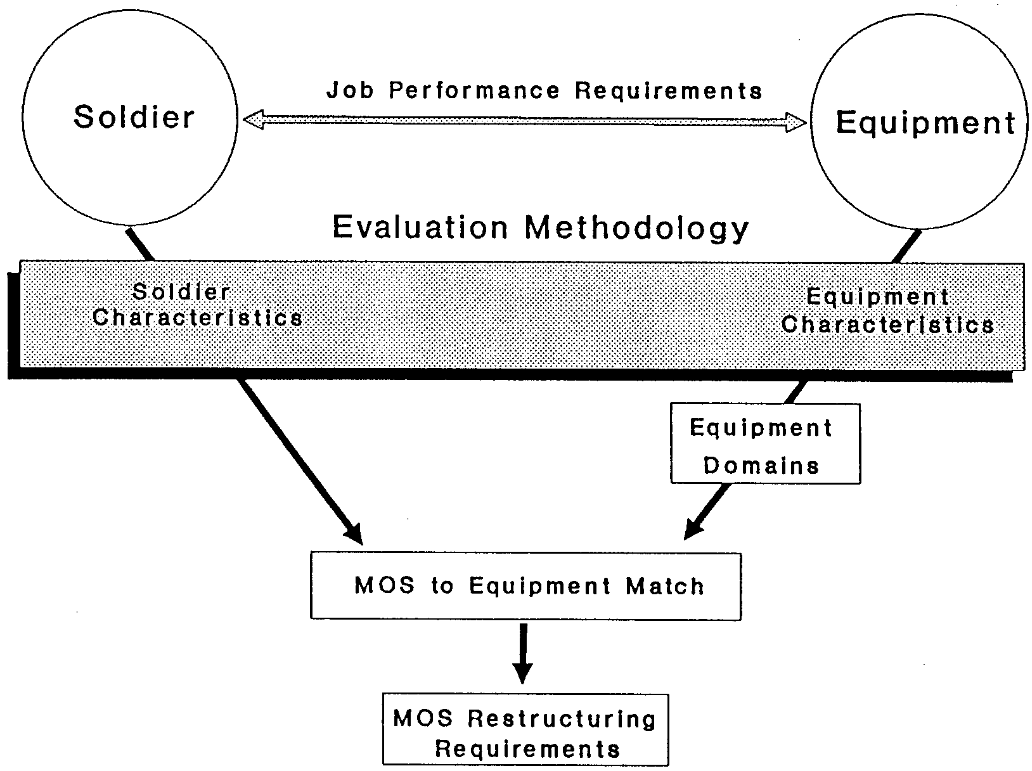

Figure 1. Focus of research effort: Determination of "equipment domains".

man-system relationship. There is the need to develop a common vocabulary to describe equipment systems. As noted by Shipman, Bing, and Finley (1990), the lack of a descriptive common language for equipment items is a problematic issue that must be addressed in any future evaluation involving equipment. The determination of equipment domains provides an economical vehicle to summarize information about equipment and attach convenient meaningful labels to that information. This will facilitate communication and understanding between MANPRINT interests. This common language has the potential to influence the development of new weapons systems, the effective integration of soldiers and equipment, and the determination of subsequent MOS restructuring requirements. Equipment domains may provide a common reference point from which to determine potential equipment functions and parameters which will maximize the capability of manned systems throughout the life cycle of the system.

Equipment Domains: Preliminary Concepts

An equipment domain is defined as a collection of equipment items which have been clustered based on their similarity on a set of equipment attributes. Equipment items having common characteristics based on these attributes are assigned to the same domain. Given this operational definition, a clear conceptual understanding of how equipment domains might be utilized in MOS restructuring is necessary. Figure 2 illustrates a concept, the "Equipment Domain Methodology". The methodology is presented here in the form of a hypothetical MOS restructuring scenario and begins with the introduction of a new equipment end item. The scenario assumes that functional, effective equipment domains have been established utilizing the current equipment inventory. Each previously established equipment domain would be associated with an operator and a maintainer MOS.

The first step in the Equipment Domain Methodology is to develop a profile of the new equipment item through a process of assigning attributes and related values to the item. The assignment is made from a purely equipment-based perspective. As part of this process, for example, a determination may be made as to the technological classification, function, and capabilities of the item. The new equipment item is thus defined in terms of its own unique attribute profile. The second step involves assigning the equipment item if possible to a domain or cluster of equipment items which have related or similar attribute profiles. If it is not possible to assign the item to an existing domain, a new domain will need to be created. By virtue of the domain assignment, an operator and maintainer would be designated for the new end item. If the item has been placed within an existing domain, an assessment of the impact of that item relative to the other equipment items within that domain will be conducted. This assessment must be conducted because the

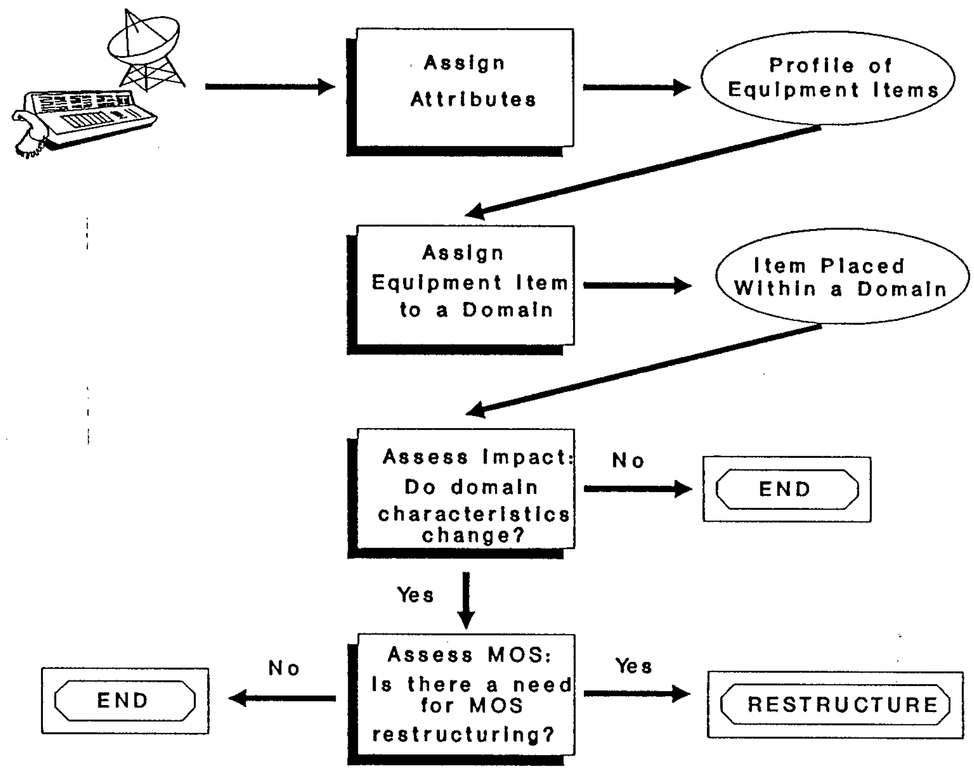

Figure 2. Equipment Domain Methodology.

life span of an equipment domain definition will be primarily a function of the duration of time important attributes of the equipment population remain stable. Thus, the assessment insures that the definition of a given domain will evolve and remain meaningful over time. This third step involves a careful examination of the integrity of the current definition of the domain into which the new item was assigned. An assessment will be made of the impact of any new equipment attributes or values of attributes that need to be accounted for in the domain definition due to the inclusion of this new end item. This will result in concluding that either there are or are not changes in the way the domain was defined. If there are no changes, then there is no need to continue to the final step and assess the MOSs associated with the domain. However, if there are changes, then an assessment must be made and an analysis conducted to determine if the MOSs assigned to the domain need to be restructured.

Each of these four steps will need to be investigated and fully developed before the Equipment Domain Methodology can be included in the "real world" MOS restructuring decision process. Each step has its own unique research issues, goals, and processes and should, therefore, be viewed as distinct segments of the larger Equipment Domain Methodology. Consequently, four developmental research models have been designated to address the full development of the Equipment Domain Methodology. As presented in Figure 3, the four models are the:

- Attribute Assignment Model;
- Equipment Domain Model;
- Impact Model; and
- MOS Restructuring Trade-off Analysis Model.

Development of the Attribute Assignment Model entails establishing and validating a method of assigning attributes and attribute values to new and developing equipment systems. The development of this model would deal with researching the most effective and efficient method to determine equipment attribute profiles early in the acquisition cycle. The development of this model would attempt to make the best utilization of the limited information associated with the early stages of system development so that initial manpower, personnel, and training (MPT) decisions could be made.

The Equipment Domain Model addresses both the creation of domains and the methods employed to place equipment items within domains. The model will examine strategies and processes involved in creating equipment domains that are functional in the determination of training requirements and MOS assignments. The model will address both operations and maintenance issues.

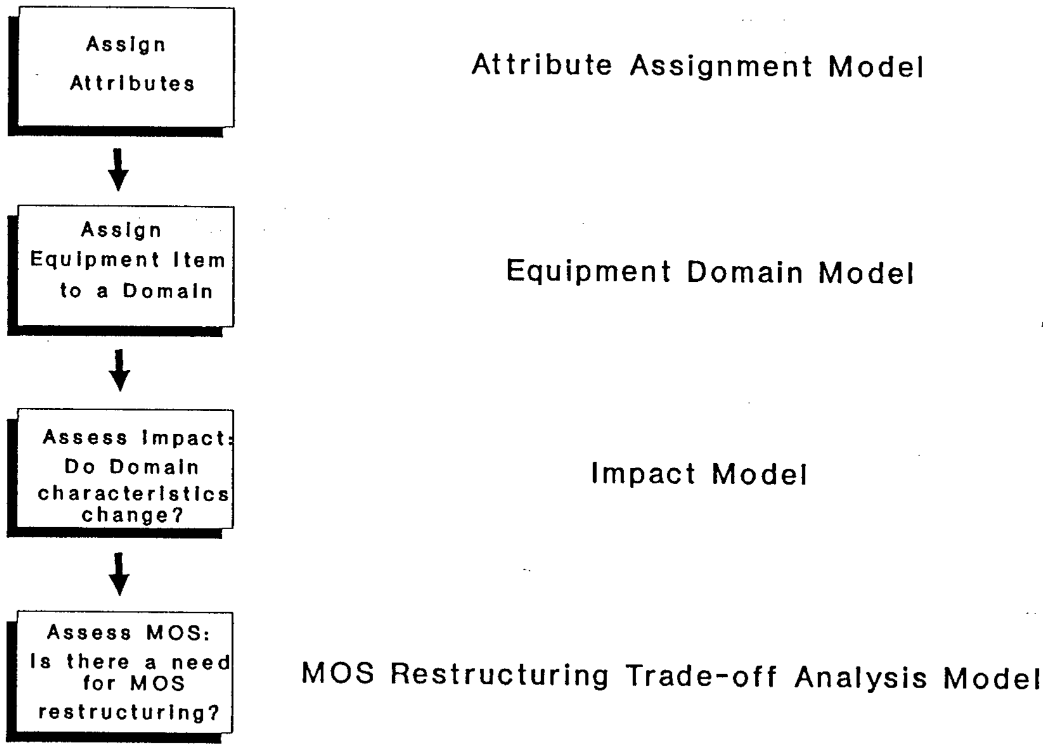

Figure 3. Research models of the Equipment Domain Methodology.

The development of the Impact Model will examine methodologies for effectively evaluating the impact of new technology and systems on the equipment domain structures created in the preceding model. The model will explore the potential impacts on the domain definition of existing domains due to the introduction of new technology and systems.

The central purpose of the Equipment Domain Methodology manifests itself through its integration into the development of the MOS Restructuring Trade-off Analysis Model. This model reflects the synthesis of data sources (i.e., MPT requirements, reliability, maintainability) that would assist the personnel analyst in identifying and assessing trade-offs related to MOS restructuring. The trade-off model would be designed to identify potential trade-off areas and provide analytical aids to determine their magnitude and significance. The introduction of this type model into the MOS restructuring process would result in trade-offs being considered in a more systematic fashion. In particular, the likelihood that a single criterion might be addressed independent of other key decision variables would be significantly reduced as a result of a comprehensive trade-off analysis model.

Research Goals and Objectives

The goal of this initial research effort is to establish the technical feasibility of the use of equipment domains in MOS restructuring. The most effective "first step" toward this goal is to develop the Equipment Domain Model, which serves as the underpinning of the Equipment Domain Methodology. If it is not possible to develop meaningful domains which describe the relationships of various equipment items and develop the descriptive criteria for these relationships, the development of the other models is meaningless.

In initiating the development of the Equipment Domain Model, a number of specific objectives have been developed for this Phase 1 effort. These objectives are:

- Identify the major dimensions of the Equipment Domain Model;
- Establish a working set of equipment attributes that describe the dimensions of the Equipment Domain Model;
- Develop data sources for this set of equipment attributes;
- Select a representative sample of Signal Branch equipment items for data collection;

- Collect pilot data describing the Signal Branch equipment sample;
- Document all data collection procedures; and
- Create preliminary, notional, equipment domains using the Signal Branch equipment sample.

Development of the Equipment Domain Model

This section details the methodology used to investigate the development of the Equipment Domain Model. The section presents the methods employed for the selection of the Signal Branch equipment sample, the data sources used, and the data collection procedures utilized in this research effort.

Equipment Sample

For the purposes of this investigation, criteria were first developed for the selection of Signal Branch equipment to be used for data collection. The criteria were used to guide an initial selection of items from the inventory of Signal Branch equipment listed in Training Circular (TC) 24-24, (1987). Two items were chosen from each section of TC 24-24. The criteria were as follows:

1. Item must not be listed in Appendix A of TC 24-24 which identifies low density equipment and potentially obsolete equipment.

2. The item must be designated Standard A (STD-A) and as such represent the preferred inventory item available to fill operational requirements.

3. The item must have a current National Stock Number (NSN) or Technical Manual (TM) to reference when obtaining information on the equipment item.

Following this initial selection, the sample was reviewed by subject matter experts (SMEs) to ensure that the selected sample was truly representative of the current inventory of Signal Branch equipment. This review resulted in some deletions and additions to the sample list. The criterion that "the item must be a stand alone end item when issued" was also added as an outcome of the SME review. The final Signal Branch equipment sample and selection criteria used for this investigation are shown in Table 1.

Equipment Dimensions, Attributes, and Data Sources

The successful development of the Equipment Domain Model rests primarily on the strategies and processes used to develop a meaningful profile of an equipment item. Without this profile, the creation of domains and the placement of equipment items within domains is not possible. Therefore an attempt was made to model the process of building equipment profiles utilizing the sample of existing equipment items. A detailed examination

Table 1

Signal Branch Equipment Sample

Selection Criteria:

1. Item must not be listed in Appendix A of TC 24-24 which identifies low density equipment and potentially obsolete equipment or be otherwise known to be obsolete or a low density item.
2. Item must be a stand alone end item when issued.
3. The item must be designated Standard A (STD-A), and as such represent the preferred inventory item available to fill operational requirements.
4. The item must have a current National Stock Number (NSN) or Technical Manual (TM) to reference when obtaining information on the equipment item.

Sample Items:

TA-838/TT Telephone Set
TSEC/KY-68 Digital Subscriber Voice Terminal
SB-22/PT Manual Telephone Switchboards
AN/UGC-74 Terminal Communications
AN/GXC-7A Tactica Facsimile Set
AN/UXC-7 Tactical Digital Facsimile Set
TS-3647/G Telephone Test Set Cable
AN/PRC-68 Radio Set (Note: or replacement)
AN/PRC-119 Radio Set (SINCGARS-V)
AN/GRC-106
AT-784/PRC Loop Antenna
OE-303 Half-Rhombic VHF Antenna
AN/TTC-39A(V)1 Automatic Telephone Central Office
AN/TTC-41A Automatic Telephone Central Office
AN/TYC-39(V) Automatic Message Switch
AN/TCC-65 Telephone Terminal
AN/TRC-112 Radio Terminal Set
AN/TRC-113(V)1 Radio Repeater Set
AN/TRC-117(V) Radio Terminal Set
AN/TRC-121 Radio Terminal Set
AN/TRC-138A Radio Repeater Set
AN/TRC-145(V)1 Radio Terminal Set
AN/TRC-145B(V)2 Radio Terminal Set
AN/TRC-170(V) Radio Terminal Set
AN/TRC-173 Radio Terminal Set
AN/TRC-174 Radio Repeater
AN/TRC-175 Radio Terminal Set
AN/TSC-85A Satellite Communications Terminal
AN/TSC-93A Satellite Communications Terminal
AN/TYQ-30(V) Comm. System Control Element
OL-415/AN/TYQ-35(V) Sys. Cont. Grp., Tech.
AN/GRC-224(P) Radio Set
AN/TRC-190(V)3 LOS Multichan. Radio Terminal
AN/TRC-191 Radio Access Unit
AN/TTC-47 Node Center Switch
AN/TTC-48(V) Small Extension Node Switch
AN/VRC-97 MS Radiotelephone Terminal
TA-1035/U Telephone Digital Nonsecure Voice
AN/GRC-193 HF Radio Set

of equipment characteristics was conducted and five potential dimensions upon which to build this profile were established. As illustrated in Figure 4, the potential dimensions were: Operations and Maintenance Requirements, Associated Skills and Abilities, Technology, Knowledge Requirements, and Resource Impacts.

The dimensions of Associated Skills and Abilities, and Knowledge Requirements were not used in the present effort. Akman Associates, Inc. is currently under contract to ARI for a related research effort into MOS restructuring that addresses the abilities and skills dimension. This effort at the U.S Army Intelligence Center and School (USAICS) is examining the refinement of a methodology for determining the abilities and skills represented by MOSs, and potentially required by equipment systems for operators and maintainers. If successful, the methodology will provide a vehicle for determining equipment driven abilities and skills profiles for equipment items. This methodology would then be integrated with methodologies developed under the present effort. The integration of the abilities and skills methodology will be considered in future research. Consideration of the knowledge dimension was also designated a topic of future research efforts to further develop the Equipment Domain Model. The present effort thus focused on the three following dimensions:

- Operations and Maintenance Requirements;
- Technology; and
- Resource Impacts.

Equipment attributes associated with each of the three dimensions were identified. Those identified as Operations and Maintenance Requirements attributes were: Function, Capabilities, Features, Major Components, Technical Characteristics, Maintenance Levels, Type of Maintenance Required, Malfunctions, and Actions Taken. Those identified as Technology attributes were: Model Number Designation and Major Technological Classification. Those identified as Resource Impacts attributes were: Average Man-hours per Action, Spare Parts Used, and Organizational Location. Each attribute identified was given a clear definition and a designated data source. The data sources were to be utilized to acquire the values of attributes for a given equipment item.

A complete list of attributes, attribute definitions, and associated data sources is displayed in Table 2. Of these 14 attributes, eight were used for pilot data collection. Model number designation was eliminated because this information would bias the data collection effort. The attribute data to be supplied from the Army Materiel Support Activity (AMSA) were not available at the time of data collection so these attributes were removed. Five of the eight attributes used in this study are

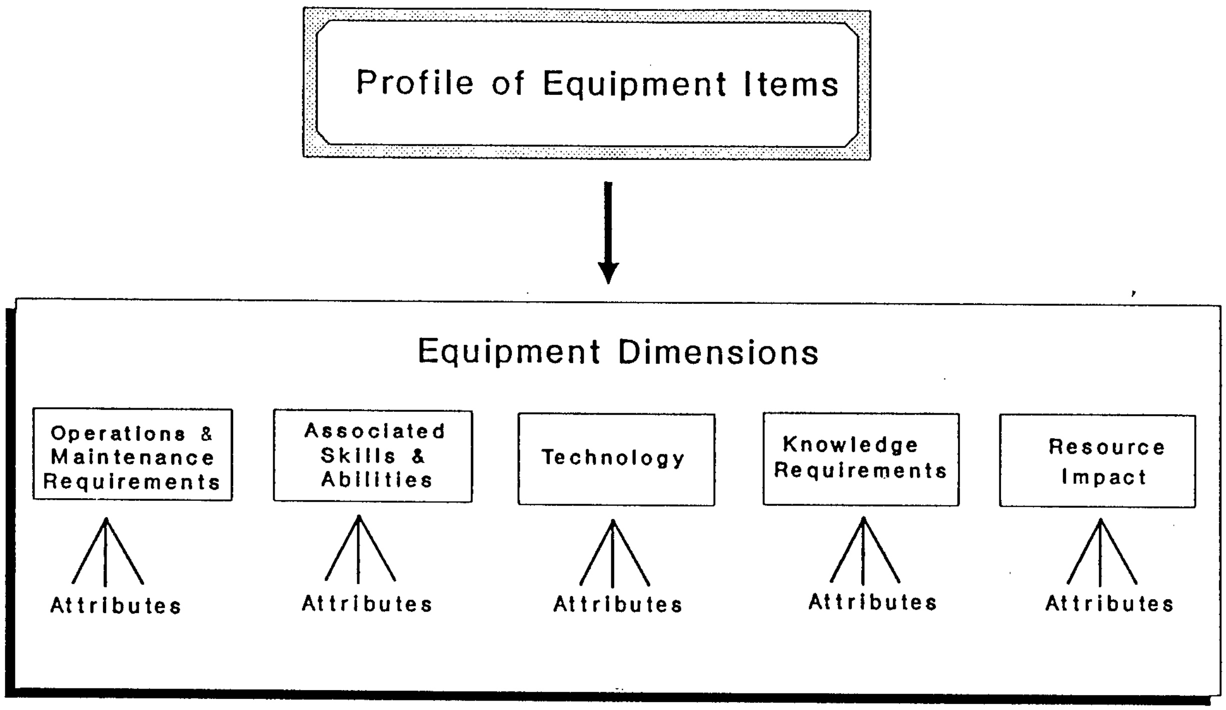

Figure 4. Equipment dimensions.

Table 2

Attribute Definitions

Information Sources:	**TC 24-24, Technical Manuals**
Model No./ Designation -	As defined in the Joint Electronics Type Designation System.
Major Technological Classification -	Defines the major type of technology utilized by the end item.
Function -	Defines the principal purpose of the end item. There may be several principal functions of a given end item.
Capabilities -	Defines those aspects of the item which further define the item's function. For example, if an items function is that it is used to compose, edit, and transmit print material, it may have the capability to do this in ITA2 or ASCII code.
Features -	Defines those aspects of the item which contribute to the efficient operation of the item (i.e., lightweight, portable, unique interfaces, equipment links, etc.).
Major Components -	Lists the major components of the end item which are required to meet the end item's mission.
Technical Characteristics -	Defines those unique characteristics of the end item which impact the ultimate functionality of the item or system (i.e., type of signal, frequency range, power requirements, weight, transmission range, etc.).
Maintenance Levels -	Defines the levels of maintenance and the intended maintenance channels to be used to maintain a given item.
Information Sources:	**Army Materiel Support Activity, Intermediate Maintenance Database.**
Type of Maintenance Required -	Defines the nature of the maintenance actions taken for a given end item (i.e., scheduled, unscheduled, etc.).
Malfunctions -	Defines the types of malfunctions which have been documented for a given end item.
Actions Taken -	Defines those maintenance actions which have been documented to correct a given malfunction for an end item.
Average Man-Hours per Action Taken -	Defines the average number of man-hours documented for a given maintenance action to be completed to correct a specific malfunction of an end item.
Spare Parts used -	Defines the spare parts utilized to correct a given malfunction.
Information Sources:	**Table of Organization and Equipment (TOE)**
Organizational Location -	Defines the location of the end item within the Army force structure (i.e., at Echelons above Corp, Division, etc.).

identical to those used in high instructional training transfer (HITT) (Ryan, 1990). Although coincidental, this similarity tends to validate the use of these attributes in building equipment profiles.

Data Collection Procedures and Findings

The present investigation involved two distinct data collection efforts. The first effort involved the accumulation of data relevant to the development of equipment profiles of the sample Signal Branch equipment items. The second effort, the Equipment Domains Assessment Procedure (EDAP), involved collecting data from SMEs regarding: 1) their strategies and processes used in creating equipment domains, 2) the assignment of equipment items into domains accounting for operations and maintenance issues, and 3) the functional utility of the equipment profiles built for the EDAP. Both data collection efforts are detailed in this section.

Profile development. Equipment profiles were built using two methods. The first methodology involved the participation of a SME and was used for the attributes of the Operations and Maintenance Requirements and Technology dimensions. As a result of the findings reported by Shipman, et. al. (1990) SME questionnaires and interviews were not used to assess the values of attributes of equipment items to build equipment profiles. While attempting to test and evaluate an equipment evaluation form, Shipman, et. al. found that the SMEs used in their study often used different words to describe the same types of systems. To prevent this type of confounding, the present study utilized a single SME to glean the values of the various attributes from existing U.S. Army documentation. When data were collected through another source, the same SME reviewed the collected data and made revisions where necessary. This method was used to insure consistency between items of equipment in the sample and simplify the data collection procedures. Inherent in this methodology is the assumption that the data sources reflect accurate and consistent data.

The second methodology involved requesting maintenance data on the equipment sample from the AMSA. Unfortunately, the data could not be obtained in a usable format for this Phase 1 effort. These data were to be used to describe the values of some Operations and Maintenance Requirements Attributes and the Resource Impacts Attributes. It was hypothesized that utilizing the AMSA data would allow the equipment profile to account for maintenance requirements and unique maintenance resource impacts. These data would provide attribute values for equipment-driven maintenance activities and tasks for each item of equipment. Specifically, values for the types of malfunctions, when and how the malfunctions were detected, the actions taken to correct the

malfunctions, and the resources required to perform the actions could be valuable.

The collected data were compiled onto equipment "data sheets". Each data sheet reflected a single item of equipment, its attributes, and the values of those attributes. The data sheets from the entire sample of 39 items are included in Appendix A. Utilizing the equipment sample data sheets, a computerized data base was developed. The data base was developed to ease the process of sorting and manipulating the data in further examining the processes involved in the determination of equipment domains and the assignment of items to the created domains.

EDAP. The EDAP was developed to meet several specific objectives. The first objective was simply to create equipment domains utilizing the expertise of SMEs. The second objective was to acquire information regarding potential processes and strategies in the determination of equipment domains. The final objective was to collect data to verify the success of the profile development process which involved the determination of equipment dimensions, attributes, and data sources. The EDAP was designed to walk the SMEs through the mechanisms of creating equipment domains, documenting the processes and strategies used in the creation of equipment domains. Subjective data were then collected regarding the utility of the equipment profiles used in this exercise through a post-task questionnaire. Thus, the SMEs had to be familiar with both the characteristics of individual items of equipment and the processes involved in critically evaluating the similarities and differences of equipment characteristics. The sequential steps of the EDAP are illustrated in Figure 5.

To accomplish these objectives in this initial pilot testing of the EDAP, the New Systems Training Group (NSTG) at Fort Gordon was chosen to provide SMEs. The NSTG is responsible for the development of training programs for new technologies and equipment. Thus, the NSTG has considerable expertise in the critical evaluation of new equipment in terms of potential training requirements and potential impacts on existing training programs. The EDAP was administered to two separate groups of three NSTG personnel each and the procedure took approximately two hours for each group. The EDAP is included in Appendix B.

Through the pilot testing of the EDAP, a number of important findings were documented that impact the future development of the Equipment Domain Model and provide insights into the feasibility of using "equipment domains" in the process of MOS restructuring. These findings are presented and discussed below in the following order: 1) Findings specifically related to the task of creating equipment domains and MOS assignments; and 2) general comments and responses made on the post-task questionnaire.

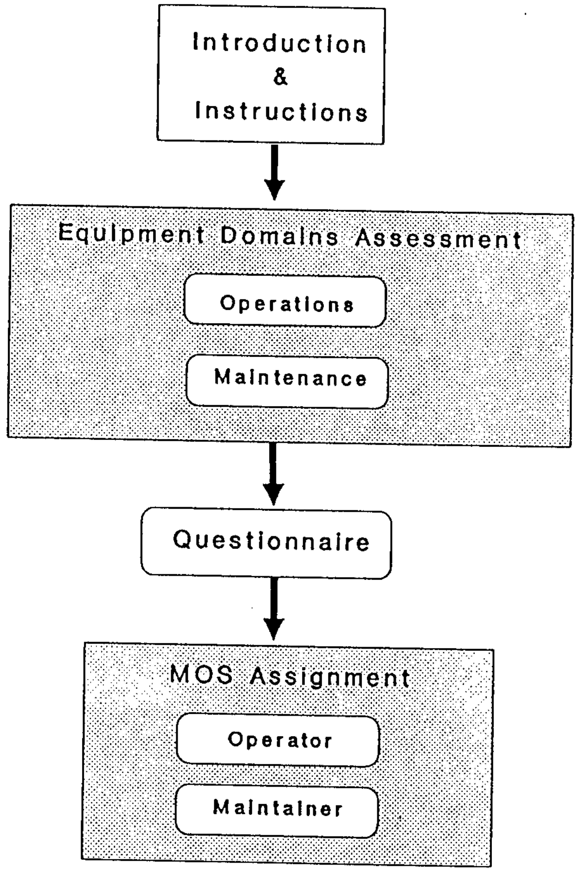

Figure 5. Equipment Domains Assessment Procedure (EDAP).

Creation of equipment domains. In utilizing the EDAP, two panels were asked to create and name a set of equipment domains using the attribute data sheets from the sample of Signal Branch equipment items. The two panels were asked to perform this task in regard to both operations and maintenance criteria. Using the attribute data sheets included in the EDAP, both groups of NSTG personnel were able to effectively create equipment domains based on operations criteria despite using somewhat divergent overall strategies. By observing the interaction of the panel members and the process of developing the domains the investigator noted that Panel 1 appeared to have a better understanding of the technical aspects of the equipment then did Panel 2. The first panel tended to focus on specific values of attributes to develop criteria while Panel 2 tended to describe the equipment items in more global terms. Panel 2 tended to focus on the implications certain values might have on the performance of operations tasks. The operations domains created and the associated MOS assignments by both panels are presented in Tables 3 and 4.

A careful examination, comparing and contrasting, of the two operations domains supports the notion that Panel 1 had a better understanding of the equipment systems. The Panel 1 domains appear to have more utility in that the Panel 2 domains do not appear to reflect the most efficient organizational strategy. For example, Panel 2 created one large domain ("Radio Sets") and then created many smaller domains. In comparing the two domain sets, the smaller domains of Panel 2 can be combined and the large domain broken down into blocks of equipment to create domains along the lines of Panel 1. What is significant is that both panels organized the same "blocks" of equipment even if they did not create unique domains for each block. For example, both panels created what amounts to a domain for general purpose user (GPU) items. Panel 1's domain 4 and the combination of Panel 2's domains 4 and 5 comprise essentially the same equipment items. Panel 1 was able to create a domain and sub-domain (2 and 2a) that are consistent with the merger involving MOS 31M and MOS 31Q. The panel was able to effectively determine the equipment similarities from the attribute profiles and cluster the items accordingly.

The analysis of the operations domains also revealed several findings that must be interpreted with caution. The domains created by Panel 1 could easily be organized into divisions currently existing within the training department at Fort Gordon. This finding could easily be a result of the panelist's backgrounds biasing the functional groupings. Replication of this finding outside the NSTG is required before conclusions can be drawn regarding the functional utility of these domains.

Although some consolidation of MOSs did occur (five common MOSs were assigned for the majority of the items), the MOS

Table 3

Operations Domains Created by Panel 1

Domain 1	Domain 2	Domain 2a	Domain 3	Domain 4	Domain 5
Radio Transmission System	Digital Grp. Multiplexing Equip.	Analog Grp. Multiplexing Equip.	MSE Equipment and Assoc. Parts	Associated Items & Equipment	Switches
#6 AN/PRC-119 SINCGARS-V Radio Set	#21 AN/TSC-93A Satellite Comm. Terminal	#8 AN/TRC-113A(V)1 Radio Repeater Set	#3 AN/GRC-224(P) Radio Set	#39 TSEC/KY-68 DSVT	#22 AN/TTC-39A(V)1 Auto. Telephone Central Office
#5 AN/PRC-68 Radio Set	#20 AN/TSC-85A Satellite Comm. Terminal	#9 AN/TRC-117(V)() Radio Terminal Set	#36 TA-1035/U DNVT	#30 AN/UXC-7 Tactical Digital Facsim.	#23 AN/TTC-41() Auto. Telephone Central Office
#1 AN/GRC-106 Radio Set	#17 AN/TRC-175 Radio Terminal set	#13 AN/TRC-145B(V)1 Radio Terminal Set	#34 OL-415/TYQ-35(V) Sys. Control Grp., Tech.	#4 AN/GXC-7A Tactical Facsimile Set	#27 AN/TYC-39 Auto. Message Switch
#2 AN/GRC-193 HF Radio Set	#16 AN/TRC-174 Radio Repeater	#12 AN/TRC-145A(V)1 Radio Terminal Set	#31 AN/VRC-97 MS Radiotelephone Terminal	#37 TA/838/TT Telephone Set	#35 SB-22/PT Manual Telephone Switchboard
#32 AT-784/PRC Loop Antenna	#14 AN/TRC-170(V) Radio Terminal Set	#7 AN/TRC-112 Radio Terminal Set	#18 AN/TRC-190(V)3 LOS Multichan. Radio Term.	#29 AN/UGC-74() Terminal Communications	MOS: 36L, 72E, 72G, 74C
#33 OE-303 Half-Rhombic VHF Antenna	#15 AN/TRC-173 Radio Terminal Set	#10 AN/TRC-121 Radio Terminal Set	#19 AN/TRC-191 Radio Access Terminal.	#26 AN/TTC-65 Telephone Terminal	
MOS: 31C	#11 AN/TRC-138A Radio Repeater Set	MOS: 31M	#24 AN/TTC-47 Node Center Switch	MOS: 31F, 31Y-K7, 31M, 31Q	
	#28 AN/TYQ-30(V)1 Comm. System Control Element		#25 AN/TTC-48(V) Small Ext. Node Switch		
	#38 TS-3647()/G Telephone Test Set Cable Orderwire Unit		MOS: 31F, 31Y-K7		
	MOS: 31M, 31Q				

Table 4

Operations Domains Created by Panel 2

Domain 1

Physical Mgmt./Automation Mgmt.

#28 AN/TYQ-30(V)1
Comm. Sys. Cntrl. Elmt.

#34 OL-415/TYQ-35(V)
Sys. Cntrl. Grp., Tech.

MOS: 31Y, 25A, 250A, 25C, 312

Domain 2

Switching and Associated Items

#22 AN/TTC-39A(V)1
Auto. Telephone Central Office

#23 AN/TTC-41()
Auto. Telephone Central Office

#27 AN/TYC-39
Auto. Message Switch

#35 SB-22/PT
Manual Telephone Switchboard

#24 AN/TTC-47
Node Center Switch

#25 AN/TTC-48(V)
Small Ext. Node Switch

#39 TSEC/KY-68
DSVT

MOS: 36M, 31F

Domain 3

Radio Sets

#6 AN/PRC-119
SINCGARS-V Radio Set

#5 AN/PRC-68
Radio Set

#1 AN/GRC-106
Radio Set

#2 AN/GRC-193
HF Radio Set

#17 AN/TRC-175
Radio Terminal set

#16 AN/TRC-174
Radio Repeater

#14 AN/TRC-170(V)
Radio Terminal Set

#15 AN/TRC-173
Radio Terminal Set

#11 AN/TRC-138A
Radio Repeater Set

#8 AN/TRC-113A(V)1
Radio Repeater Set

#9 AN/TRC-117(V)()
Radio Terminal Set

#13 AN/TRC-145B(V)1
Radio Terminal Set

#12 AN/TRC-145A(V)1
Radio Terminal Set

#3 AN/GRC-224(P)
Radio Set

#31 AN/VRC-97
MS Radiotelephone Terminal

#18 AN/TRC-190(V)3
LOS Multichan. Radio Term.

#19 AN/TRC-191
Radio Access Terminal.

#7 AN/TRC-112
Radio Terminal Set

#10 AN/TRC-121
Radio Terminal Set

MOS: 31C, 31D, 31M

Domain 4

Telephones

#37 TA/838/TT
Telephone Set

#26 AN/TTC-65
Telephone Terminal

MOS: GPU

Domain 5

Data Devices

#30 AN/UXC-7
Tactical Digital Facsim.

#4 AN/GXC-7A
Tactical Facsimile Set

#29 AN/UGC-74()
Terminal Communications

#36 TA-1035/U
DNVT

MOS: GPU

Domain 6

Satellite Equipment

#21 AN/TSC-93A
Satellite Comm. Terminal

#20 AN/TSC-85A
Satellite Comm. Terminal

MOS: 31Q, 29Y

Domain 7

Maintenance Tools

#38 TS-3647()/G
Telephone Test Set Cable
Orderwire Unit

MOS: 31L, 31K

Domain 8

FM Radio Signal Locator

#32 AT-784/PRC
Loop Antenna

MOS: EW7

Domain 9

Antennas

#33 OE-303
Half-Rhombic VHF Antenna

MOS: 31C, 31D

assignments of Panel 1 were generally consistent with the soldier-equipment assignments described in the Personnel Proponent Handbook (1989). Again, further research is needed beyond the context of the present pilot study before solid conclusions can be drawn regarding MOS assignments and the consolidation of MOSs.

In regard to the creation of maintenance domains, Panel 1 found that creating meaningful domains based on maintenance criteria was extremely difficult. After initiating the task of creating maintenance domains, the panel became frustrated and initiated a candid discussion between the panel members regarding the difficulty of the task. Panel 1 then informed the investigator that based on the information provided, the creation of meaningful maintenance domains was not possible. The panel stated that since the data were presented by system and not broken down to the component level, maintenance domains could not be created. The panel commented that without this breakdown, the only strategy available would be to create domains based on function and technology and essentially duplicate the operations domains just created. The panel commented that although this strategy is sometimes used in actual practice to make preliminary determinations of training requirements and MOS assignments, this approach would not provide useful data for this exercise. The panel also suggested that the EDAP task involving the creation of maintenance domains be designed to create unique domains at each maintenance level. This would allow variance in domain assignment at each level of the Army maintenance system. Panel 2 encountered these same difficulties with the presentation of the equipment attribute data and, therefore, maintenance domains were not created by either panel.

<u>Questionnaire responses</u>. This section presents a summary of the data collected on the post-task questionnaire. The first section of the questionnaire was designed to gather specific information on the Army background and experience of each panelist. A review of these profiles indicates both a breadth and depth of experience in working with Army systems. All subjects were well qualified for participation in this pilot study. Profiles of the panelists from each group are presented in Tables 5 and 6. The data collected for the remainder of the questions on the post-task questionnaire are summarized below. Additional comments, including verbal comments made by the panelists are also included in this summarization.

- Only one panelist indicated that he did not feel his group worked effectively in determining groupings for Operations and Maintenance. This panelist provided the following explanation:

Table 5

EDAP Panelist Profile: Panel 1

	QUESTION	Subject 1	Subject 2	Subject 3
1.	Length of time with the NSTG?	4 yrs.	2 yrs.	6 yrs.
2.	Current Grade?	GS-12	SSG	GS-11
3.	Title?	Training Specialist	Project NCO	Training Specialist
4.	Active duty?	No	Yes	No
	a. Years of Service?	N/A	15	N/A
	b. Branch?	N/A	Army	N/A
	c. MOS-AOC?	N/A	74F30	N/A
5.	Related military experience?	Yes	N/A	No
	a. Years of Service?	20	N/A	N/A
	b. Branch?	Army	N/A	N/A
	c. MOS-AOC?	31C, 72E, 31N, 31V, 31Z	N/A	N/A

Table 6

EDAP Panelist Profile: Panel 2

	QUESTION	Subject 1	Subject 2	Subject 3
1.	Length of time with the NSTG?	5 yrs.	3½ yrs.	4 yrs.
2.	Current Grade?	GS-11	E7	GS-11
3.	Title?	Training Specialist	Data Proj. NCO	Elec. Tng. Specialist
4.	Active duty?	No	Yes	No
	a. Years of Service?	N/A	17	N/A
	b. Branch?	N/A	Army	N/A
	c. MOS-AOC?	N/A	39V	N/A
5.	Related military experience?	Yes	N/A	No
	a. Years of Service?	22 yrs.	N/A	N/A
	b. Branch?	Signal	N/A	N/A
	c. MOS-AOC?	31G, 31Z	N/A	N/A

"Operations worked to some degree, maintenance didn't work well due to the lack of information as follows (1. Bit-Bite, 2. Levels of maintenance, 3. Modularization, etc.)".

- All panelists indicated that other organizational structures within the Army (i.e., personnel proponent) would agree with the groupings their panels specified. The panelists indicated that the domains they created were consistent with the approach currently used by the NSTG to organize equipment within training departments for the development of training. The panelists felt that this is a logical organization and thus would not be questioned by other agencies.

- All panelists indicated that all attributes had some bearing on the creation of equipment groupings and therefore none of the attributes should be eliminated for either operations or maintenance. The panelists did acknowledge that some attributes were more heavily weighted than others. This is reflected by the rank orders assigned to the attributes with regard to their importance. These rank orders are presented below.

  Even though maintenance domains were not created, all respondents indicated that the attributes presented would be required to create maintenance domains, in addition to other attributes.

- For operations, there was general agreement among the panelists that all the critical attributes were presented on the data sheet. One panelist suggested that security levels should be added.

  For maintenance, the panels indicated that the task should be broken down to address each maintenance level, that the systems be broken down to the component level, and that the type of manual be specified (Soldier Performance Aid (SPA), Commercial, etc.). One panelist indicated that an indication of the type of maintenance tasks associated with components would also be helpful.

- The panelists provided the following rank order of the attributes according to the degree of importance for operations. The mean ranking for the attributes are presented in rank order.

1.	Function	1.7
2.	Capabilities	2.2
3.	Technology	3.7
4.	Features	4.5
5.	Components	4.5

6.	Technical Characteristics	5.2
7.	Maintenance Concept	6.8
8.	Operational Location	7.7

In examining the domains created by the two panels, this ordering of attributes appears consistent with the strategies used and criteria developed for the various domains.

This rank ordering was not completed for maintenance because the panels did not complete the task of creating maintenance domains.

- All panelists felt that their panel would generally agree with their individual rankings for Operations.

Although the EDAP fell short of providing a successful format for the investigation of potential maintenance domains, the findings document the ability to create meaningful domains from profiles of equipment attributes. These findings indicate that the attributes chosen as part of the profile development process and the values of those attributes provided the necessary baseline from which to cluster equipment items. This conclusion is supported both through the successful organizational strategies employed in the creation of the operations equipment domains and by the responses to the various questionnaire items. By utilizing the NSTG domains and inclusion criteria as a model, the process and strategies used in the creation of equipment domains can be successfully modeled through automated data base manipulation.

Conclusions

Feasibility of Using Equipment Domains in MOS Restructuring

Although the findings of this Phase 1 effort are limited to operations, they support the contention that items can be clustered into meaningful groups based on related or similar attribute profiles. The present effort was able to establish: 1) a working set of equipment-driven attributes, 2) data sources for fielded equipments that provide values for those attributes, 3) potential strategies for domain assignment, and 4) a systematic methodology of acquiring and verifying attribute profile data. The present effort establishes the feasibility of creating a functional Equipment Domain Model for inclusion in the Equipment Domain Methodology to be used in MOS restructuring.

Further Development of the Equipment Domain Model

To ensure full confidence in the feasibility of developing the Equipment Domain Model, several key issues must be resolved. First, alternative maintenance attributes and data sources must be developed and the EDAP methodology must be expanded to allow for the creation of maintenance domains. As stated earlier in this working paper, the format of the pilot EDAP was not robust enough to allow for the successful determination of domains based on maintenance criteria.

Second, the AMSA maintenance data, or a like data source, could greatly enhance the attribute profiles of Signal Branch equipment systems. These maintenance data would not only enhance the maintenance profile but would allow the overall system profile to account for the Resource Impacts dimension. If the AMSA data cannot be obtained, alternative attributes for this dimension will have to be developed or the dimension will have to be dropped entirely.

Third, research must be conducted to determine the level of indenture to which an attribute profile must extend to allow for the creation of meaningful domains. This issue is particularly relevant to the inadequacies of the pilot EDAP and the determination of maintenance domains. The NSTG participants in this effort recommended that the systems be broken down to a lower component level. The utility in doing this needs to be documented and an effective level of indenture determined through an empirical study.

Fourth, further research should be conducted into the development of attributes for the knowledge dimension and the integration of the abilities and skills methodology being

developed through a related research effort. The addition of these dimensions and their associated attributes would make the current model significantly more reliable.

Fifth, potential strategies in the development of effective equipment domains should be explored at various branches within the Army (personnel proponent) to address their specific needs. The domains created in the present effort, based on only a sample, address only Signal equipment and do not provide definitive domains for the Army Signal Branch equipment inventory. They simply reflect logical strategies for the organization of the equipment items based on the opinions of NSTG personnel. Further research is needed to explore various approaches to determine the most efficient strategy or strategies that address the needs of the various Army agencies.

Future Direction

The present effort has demonstrated the feasibility of developing the Equipment Domain Model. This work supports the further development of the Equipment Domain Methodology.

Based on the research to date, there have emerged at least two major issues requiring resolution: 1) the need for data to create maintenance domains and 2) determination of the appropriate level of indenture for equipment items. Solutions to these issues will allow for a more complete formulation of the Equipment Domain Model; additionally, these results are also required for the development of the other three models of the Equipment Domain Methodology.

The continuation of this research should focus on resolving the "maintenance" and "level of indenture" issue by: 1) developing alternative maintenance attributes and data sources including the AMSA data to enhance the EDAP methodology and 2) performing research to determine the appropriate level of indenture for creating equipment domains. Upon the conclusion of these tasks, a decision can be made whether to enhance the Equipment Domain Model or proceed to the development of one of the other three models of the Equipment Domain Methodology. For example, the Attribute Assignment Model may be the next logical step.

It is further recommended that this work continue to be performed at the U. S. Army Signal Branch. At this early stage in the development of the Equipment Domain Methodology, there is more to be gained by maintaining the continuity of this research then by shifting to another branch of the U.S. Army.

Following this course of action, ARI will potentially have an Equipment Domain Methodology developed to a level of detail and with documentation suitable for use by proponent agencies.

Alternatively, if work is initiated on the Attribute Assignment Model, ARI will have specifications formulated for half of the Equipment Domain Methodology and a solid basis for continued research.

References

Fleishman, E. A. and Quaintance, M. K. (1984). Taxonomies of human performance: The description of human tasks. Orlando: Academic Press, Inc.

Ryan, A. (1990). HITT Training Methodology. (ARI Research Product). Fort Gordon, Georgia: Army Research Institute Field Unit.

Shipman, M. G. and Finley, D. L. (1989). Military Occupational Specialty (MOS) Restructuring: an annotated bibliography. (ARI Research Note). Fort Gordon, Georgia: Army Research Institute Field Unit.

Shipman, M. G., Bing, V. B., and Finley, D. L. (1990). Test and evaluation of the Military Occupational Specialty (MOS) equipment evaluation form. (ARI Working Paper FG90-201). Fort Gordon, Georgia: Army Research Institute Field Unit.

U.S. Army Signal Corps. (1989). Personnel Proponent Handbook. U.S. Army Signal Center, Fort Gordon, Georgia.

Acronyms

AMC . . . . . Army Materiel Command

AMSA . . . . Army Materiel Support Activity

ARI . . . . . Army Research Institute

CMFs . . . . Career Management Fields

EDAP . . . . Equipment Domains Assessment Procedure

GPU . . . . . General Purpose User

MANPRINT . . Manpower and Personnel Integration

MOSs . . . . Military Occupational Specialties

MPT . . . . . Manpower, Personnel, and Training

NSN . . . . . National Stock Number

NSTG . . . . New Systems Training Group

SMEs . . . . Subject Matter Experts

SPA . . . . . Soldier Performance Aid

STD-A . . . . Standard A

TC . . . . . Training Circular

TM . . . . . Technical Manual

USAICS . . . U.S Army Intelligence Center and School

Appendix A. Data Sheets of the Signal Branch Equipment Sample

This appendix contains the data sheets for all 39 items of the Signal Branch equipment sample. The first two pages provide a Table of Contents for this appendix, followed by the data sheets.

Appendix A

Table of Contents

Appendix A

Table of Contents (Con't)

END ITEM	YES
COMPONENT	YES
MODEL	AN/GRC-106( )
NOMENCLATURE	Radio Set

ATTRIBUTES

TECHNOLOGY	1.	HF-SSB radio set
	2.	Used with SSB RATT
FUNCTION		Mobile link in a HF communications network
CAPABILITIES	1.	Vehicular mounted
	2.	Secure radio communications
FEATURES		Compatible with standard AM radios
MAJOR COMPONENTS	1.	Receiver Transmitter RT-662/GRC or RT-834/GRC
	2.	Amplifier AM-3349/GRC

TECHNICAL CHARACTERISTICS

Frequency Range	2.0 to 29.999 MHz (AN/GRC-106) 2.0 to 29.9999 MHz (AN/GRC-106A)
Planning Range	Ground wave, 80 km (50 mi) Sky wave, 160 to 2,400 km (100 to 1,491 mi)
Number of Channels	RT-662: 28,000, spaced every 1 kHz RT-834: 280,000, spaced every 100 Hz
RF Output	400 W PEP
Antenna	4.57m (15 ft) whip, or doublet AN/GRA-50
Security Device	TSEC/KY-65
Power Input	27 V DC

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORP	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/GRC-193
NOMENCLATURE	HF Radio Set

ATTRIBUTES

TECHNOLOGY
1. IHFR system

FUNCTION

Mobile link in an HF communications network

CAPABILITIES
1. Vehicular mounted
2. Secure radio and data communications

FEATURES

Compatible with IHFR family

MAJOR COMPONENTS
1. Receiver-Transmitter RT-1209
2. Amplifier-Converter AM-6879
3. Amplifier, Radio Frequency AM-6545
4. Coupler, Antenna CU-2064
5. Mount, Electrical Equipment MT-() GRC 193
6. Handset H-189/GR

TECHNICAL CHARACTERISTICS

Frequency Range	2 to 30 MHz Separation
100 Hz channel	
Planning Range	Ground wave, 80 km (50 mi) Sky wave, 160 to 2,400 km (100 to 1,491 mi)
Number of Channels	280,000
RF Output	400 W PEP
Antenna	4.57m (15 ft) whip, or doublet AN/GRA-50
Security Device	TSEC/KY-65
Power Input	27 V DC

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX		XXXX		XXXX		XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/GRC-224(P)
NOMENCLATURE	Radio Set

ATTRIBUTES

TECHNOLOGY	1.	MSE DTH
FUNCTION		Provides intra-nodal connectivity between switches.
CAPABILITIES	1.	Throw-on-the-ground component or mounted in TRC-190(V)( )
	2.	Secure radio communications link
FEATURES		Compatible with MSE
MAJOR COMPONENTS	1.	1ea Control Unit
	2.	1ea RF Unit
	3.	1ea Antenna

TECHNICAL CHARACTERISTICS

Frequency Range	14.50 to 15.35 GHz
Transmission Range	2 to 5 km
Power Input	28 V DC
TDM Data Rates	256, 512, 1024, and 2048 kb/s

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	1	1

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX			

Note: A #1 under the GS/DEP column signifies GFE normal procedures, with MSE unique items returned to GTE at these levels.

END ITEM	YES
COMPONENT	YES
MODEL	AN/GXC-7A
NOMENCLATURE	Tactical Facsimile Set

ATTRIBUTES

TECHNOLOGY

1. Electronic facsimile

FUNCTION

Electronic transmission/reception of documents containing black and white, color, or gray shades.

CAPABILITIES

1. Will operate over existing and proposed standard voice radios and wire circuits.
2. Will operate using standard or vehicular power

FEATURES

1. Lightweight
2. Rugged
3. Portable
4. Low power

MAJOR COMPONENTS N/A

TECHNICAL CHARACTERISTICS

Printing	Any paper, using carbon paper transfer, transparencies, map overlays, and view graphs
Power Requirements	115/206 V AC, 47 to 400 Hz or 22 to 32 V DC, 50 W
Weight	24 kg including carrying case

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
					XXXX	XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/PRC-68
NOMENCLATURE	Radio Set

ATTRIBUTES

TECHNOLOGY 1. Hand-held transceiver

FUNCTION Provides two-way radiotelephone communication

CAPABILITIES 1. Can provide secure speech operation

FEATURES

MAJOR COMPONENTS N/A

TECHNICAL CHARACTERISTICS

Frequency Range	30 MHz to 79.95 MHz
Planning Range	300 m, short antenna; 1.6 km, long antenna
Power Output	1 W
Power Source	BA-1588/U
Antenna	Telescopic (built in)
Tuning	Detent (internal, not accessible to operator)
Squelch	150-Hz tone
Type of Service	30KOF3E
Weight	1.3 kg

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX		XXXX		XXXX		XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/PRC-119
NOMENCLATURE	SINCGARS-V Radio Set

ATTRIBUTES

TECHNOLOGY

1. VHF-FM radio set, manpack

FUNCTION

Provides short or long-range communication for voice, FSK, or digital data

CAPABILITIES

1. Single-channel operation
2. Jam-resistant, frequency hoping mode

FEATURES

1. 16-element key pad for push-button tuning
2. Built-in self test with visual and audio read back
3. Six channel preset for single channel operation
4. Six channel preset for frequency hopping operation

MAJOR COMPONENTS

1. Manpack antenna
2. Battery Case
3. Receiver-Transmitter RT-1439(P)/VRC
4. Data Adapter MX-10506()/VRC
5. Electronic Counter-Countermeasure Module C-11290()/VRC

TECHNICAL CHARACTERISTICS

Frequency Range	30 MHz to 88 MHz
No. of Channels	2,320 (spaced every 25 kHz)
Power Output	5 W; up to 50 W with power amplifier
Power Requirement	12 V DC
Antenna	Manpack antenna

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

AN/PRC-119 (Cont'd)

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX		XXXX		XXXX		XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-112
NOMENCLATURE	Radio Terminal Set

ATTRIBUTES

TECHNOLOGY

1. Analog tropo terminal

FUNCTION

Provides one 24-channel PCM Radio Terminal When Used in Conjunction With Telephone Terminal AN/TCC-60, AN/TCC-61, or AN/TCC-69

CAPABILITIES

1. Air or vehicular transportable tropospheric scatter radio terminal set
2. Uses AN/GRC-106 for system engineering radio link

FEATURES

Compatible with ATACS

MAJOR COMPONENTS

1. 1ea Shelter S-336/TRC-112 (modified S-250/G)
2. 1ea Radio Set AN/GRC-143
3. 1ea Antenna Group AN/TRA-37
4. 1ea Converter CV-425/U
5. 1ea Radio Set AN/GRC-106
6. 1ea Power Supply PP-4763A/GRC
7. 1ea Telephone Set TA-312/PT
8. 1ea Intercommunications Station LS-147F/FI

TECHNICAL CHARACTERISTICS

Frequency Range	4400 to 5000 MHz
Transmission Range	161 km (100 mi)
Number of Channels	24 channel full duplex when used with PCM multiplex equipment
RF Output	1 KW
Propagation Mode	Diffraction or tropospheric scatter
Antenna	AN/TRA-37
Power Requirement	115 or 230 V AC, 50 to 60 Hz
Power Consumption	15,345 W
Weight	717 kg (1,580 lb)
Vehicle Requirement	One 1 1/4-ton truck (AN/TRC-112) One 1 1/4-ton truck (AN/TRA-37)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
			XXXX		XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-113A(V)1
NOMENCLATURE	Radio Repeater Set

ATTRIBUTES

TECHNOLOGY
1. Analog radio repeater

FUNCTION

Radio repeater or radio terminal for LOS systems in forward areas.

CAPABILITIES
1. Air or vehicular transportable
2. Used as a 6/12 channel PCM radio repeater
3. Three 12 channel PCM radio terminals requires telephone terminal in this mode
4. One 12/24 channel PCM cable repeater

FEATURES

Compatible with ATACS forward areas

MAJOR COMPONENTS
1. 1ea Shelter S-250/G modified
2. 3ea Radio Set AN/GRC-103(V)( )
3. 3ea Multiplexer TD-754/G
4. 1ea Telephone Set TA-312/PT
5. 1ea Intercom Station LS-147F/FI

TECHNICAL CHARACTERISTICS

Frequency Range	Band 1 ....220 to 404.5 MHz Band 2 ....394.5 to 705.0 MHz Band 3 ....695.0 to 1000 MHz
RF Output	Band 1 ....25 W Band 2 ....15 W Band 3 ....15 W
Planning Range	80 km (50 mi)
Channelization	PCM multiplexing
No. of Channels	6/12 channel repeater; three 12 channel PCM radio terminals; 12/24 channel PCM cable repeater
Power Requirement	115 V AC, 50 to 60 Hz
Power Consumption	5,000 W
Vehicle Requirement	One 1 1/4-ton truck

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

AN/TRC-113A(V)1 (Cont'd)

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX			XXXX		XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-117(V)( )
NOMENCLATURE	Radio Terminal Set

ATTRIBUTES

TECHNOLOGY	1.	Analog radio terminal set
FUNCTION		LOS radio terminal or cable terminal
CAPABILITIES	1.	Air or vehicular transportable
	2.	Two 12-channel secure radio terminals
	3.	Or one 24-channel or two 12-channel secure cable terminals
FEATURES		Compatible with ATACS corps and above
MAJOR COMPONENTS	1.	1ea Shelter S-330( )/TRC-117(V) (modified S-280/G)
	2.	2ea Radio Sets AN/GRC-50
	3.	2ea Antennas AT-903
	4.	2ea Multiplexers TD-352/U
	5.	2ea Multiplexers TD-204/U
	6.	2ea Multiplexers TD-202/U
	7.	1ea Telephone Set TA-312/PT
	8.	2ea Converters CV-1548/G
	9.	2ea Security Equipment TSEC/KG-27 (not a basic issue item)
	10.	1ea Intercom Station LS-147F/FI

TECHNICAL CHARACTERISTICS

Frequency Range	Low band ....601.5 to 999.5 MHz High band ....1350.5 to 1849.5 MHz
RF Output	Low Band ....15 to 30 W High Band ....8 to 20 W
Planning Range	50 km (31 mi)
Channelization	TDM-PCM multiplexing
No. of Channels	One 24-channel; or two 12-channel LOS or cable terminals
Power Requirement	115 V AC, 50 to 60 Hz
Power Consumption	5,080 W
Vehicle Requirement	One 2 1/2-ton truck

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

AN/TRC-117(V)( ) (Cont'd)

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
			XXXX			XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-121
NOMENCLATURE	Radio Terminal Set

ATTRIBUTES

TECHNOLOGY	1.	Analog tropo terminal
FUNCTION		Provides two 12- or 24-channel PCM Radio Terminal When Used in Conjunction With Telephone Terminal AN/TCC-60, AN/TCC-61, or AN/TCC-69
CAPABILITIES	1.	Air or vehicular transportable tropospheric scatter radio terminal set
	2.	Uses AN/GRC-106 for system engineering radio link
FEATURES		Compatible with ATACS corps and above systems
MAJOR COMPONENTS	1.	1ea Shelter S-338/TRC-121 (modified S-280/G)
	2.	2ea Radio Sets AN/GRC-143
	3.	2ea Antenna Groups AN/TRA-37
	4.	2ea Converters CV-425/U
	5.	1ea Radio Set AN/GRC-106
	6.	1ea Power Supply PP-4763A/GRC
	7.	1ea Telephone Set TA-312/PT
	8.	1ea Intercommunications Station LS-147F/FI

TECHNICAL CHARACTERISTICS

Frequency Range	4400 to 5000 MHz
Transmission Range	161 km (100)
Number of Channels	Two 24 channel full duplex systems when used with PCM multiplex equipment
RF Output	1 kw
Propagation mode	Diffraction or tropospheric scatter
Antenna	AN/TRA-37
Power Requirement	115 or 230 V AC, 50 to 60 Hz
Power Consumption	23,400 W
Weight	2,338 kg (5,150 lb)
Vehicle Requirement	One 2 1/2-ton truck (AN/TRC-121) One 2 1/2-ton truck (AN/TRA-37)

AN/TRC-121 (Cont'd)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
			XXXX		XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-138A
NOMENCLATURE	Radio Repeater Set

ATTRIBUTES

TECHNOLOGY	1. Shortwave wideband radio (SRWBR) 2. Digital group multiplexing (DGM)
FUNCTION	1. SRWBR transmission for top-of-the-the hill (TOH) node
CAPABILITIES	1. Air or vehicular transportable 2. Secure radio/cable tactical communications 3. Multiple system deployment
FEATURES	Compatible with ATACS and TRI-TAC
MAJOR COMPONENTS	1. 3ea Radio Sets AN/GRC-144(V)3 2. 1ea Cable Modem Drive MD-1024/G 3. 1ea Multiplexer TD-1237(P)/G 4. 3ea Digital Data Modems MD-1026(P)/G 5. 1ea Voice Encryption Device TSEC/KY-57 6. 1ea Digital Secure Voice Terminal TSEC/KY-68 7. 1ea Loop Encryption Device TSEC/KG-84 8. 1ea Intercommunications Station LS-147F/FI 9. 1ea Shelter S-667/TRC-138A

TECHNICAL CHARACTERISTICS

Frequency Range	4.4 to .0 GHz
Transmission Range	
LOS	Up to 40 km (25 mi)
SRWBR	8 km (5 mi)
Cable Driver Modem	8 km (5 mi) with repeaters
RF Output:	
LOS	25 W
SRWBR	250 mW
Channelization	Time division multiplexing (TDM)
No. of Channels	LOS MW Repeater (24/144 channels) SRWBR 576-channel link Cable Terminal (72/144 channel)

Orderwires:	
Digital Voice	16 kb/s
Analog Voice	300 to 1800 Hz at 3 dB bandwidth
Weight	2,424 kg (5,340 lb)
Power Requirement	115 V AC ±6 volts, 50/60/400 Hz, 3-phase
Power Unit	PU-631

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
					XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-145A(V)1
NOMENCLATURE	Radio Terminal Set

ATTRIBUTES

TECHNOLOGY	1. Analog radio terminal set
FUNCTION	Radio, cable terminal or radio repeater terminal for LOS systems in forward areas.
CAPABILITIES	1. Air or vehicular transportable 2. Two 6/12 channel secure radio terminals 3. Two 6/12 channel secure cable terminals requires telephone terminal in this mode 4. One 12/24 channel PCM cable repeater
FEATURES	Compatible with ATACS forward areas
MAJOR COMPONENTS	1. 1ea Shelter S-250/G modified 2. 2ea Radio Set AN/GRC-103(V)1 3. 2ea Multiplexer TD-754/G 4. 2ea Multiplexer TD-660/U 5. 2ea Telephone Signal Converter CV-1548/G 6. 1ea Telephone Set TA-312/PT 7. 1ea Intercom Station LS-147F/FI

TECHNICAL CHARACTERISTICS

Frequency Range	Band 1 ....220 to 404.5 MHz Band 2 ....394.5 to 705.0 MHz Band 3 ....695.0 to 1,000 MHz
RF Output	Band 1 ....25 W Band 2 ....15 W Band 3 ....15 W
Planning Range	80 km (50 mi)
Channelization	PCM multiplexing
No. of Channels	6/12 channel repeater; two 12 channel PCM radio terminals; 12/24 channel PCM cable repeater
Power Requirement	115 V AC, 50 to 60 Hz
Power Consumption	3,000 W
Vehicle Requirement	One 1 1/4-ton truck

AN/TRC-145A(V)1 (Cont'd)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX			XXXX		XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-145B(V)1
NOMENCLATURE	Radio Terminal Set

ATTRIBUTES

TECHNOLOGY	1.	Analog radio terminal set
FUNCTION		Radio, cable terminal or radio repeater terminal for LOS systems in forward areas.
CAPABILITIES	1.	Air or vehicular transportable
	2.	Two 6/12 channel secure radio terminals
	3.	Two separate 12-channel groups of data or teletype over one secure or nonsecure channel of the Multiplexer TD-660 System 1 or 2 (channel 7 dedicated)
FEATURES		Compatible with ATACS forward areas
MAJOR COMPONENTS	1.	1ea Shelter S-250/G modified
	2.	2ea Radio Set AN/GRC-103(V)1
	3.	2ea Multiplexer TD-660/U
	4.	2ea Telephone Signal Converter CV-1548/G
	5.	2ea High-Speed Serial Data Buffer TD-1065/G
	6.	2ea Time Division Digital Multiplexer TD-1069/G
	7.	1ea Telephone Set TA-312/PT
	8.	1ea Intercom Station LS-147F/FI

TECHNICAL CHARACTERISTICS

Frequency Range	Band 1 ....220 to 404.5 MHz
	Band 2 ....394.5 to 705.0 MHz
	Band 3 ....695.0 to 1,000 MHz
RF Output	Band 1 ....25 W
	Band 2 ....15 W
	Band 3 ....15 W
Planning Range	80 km (50 mi)
Channelization	PCM multiplexing
No. of Channels	two 12 channel PCM radio terminals and two separate 12-channel groups of data or teletype
Power Requirement	115 V AC, 50 to 60 Hz
Power Consumption	3,000 W
Vehicle Requirement	One 1 1/4-ton truck

AN/TRC-145B(V)1 (Cont'd)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX				XXXX		XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-170(V)
NOMENCLATURE	Radio Terminal Set

ATTRIBUTES

TECHNOLOGY	1. Digital radio terminal set, TRI-TAC
FUNCTION	Provides tactical multichannel digital tropospheric scatter or LOS systems
CAPABILITIES	1. Air or vehicular transportable 2. One 8 to 144 channel secure radio terminal
FEATURES	Compatible with TRI-TAC at EAC
MAJOR COMPONENTS	1. 1ea Shelter S-250/G modified or S-280/G modified 2. 1ea Radio Set AN/GRC-197 3. 1ea Digital Data Group Modem MD-1026(P)/G 4. 2ea Loop Group Multiplexers TD-1235(P)/TTC 5. 1ea Trunk Group Multiplexer TD-1236/G 6. 1ea Low Speed Cable Driver Modem MD-1023(P)/G 7. 2ea Trunk Encryption Devices TSEC/KG-81 8. 2ea Dedicated Loop Encryption Devices TSEC/KG-84 9. 1ea DSVT KY-68 10. 1ea VINSON TSEC/KY-58 11. 1ea ETD KYK-13 12. 1ea Antenna System 3 m (9.5 ft) (or QRA) Antenna System 3 m (9.5 ft) 13. 1ea Voice Orderwire Control Unit C-10602/TRC-170 14. 2ea High Power Amplifiers (2 kw) ((V)2) 15. 1ea High Power Amplifier (2 kw) ((V)3) 16. 1ea TROPO Modem OM-61/TRC-170 17. 2ea Synthesizers SN-531/TRC-170 ((V)2) 18. 1ea Synthesizer SN-531/TRC-170 ((V)3) 19. 1ea High Wind Kit 951-211-1

TECHNICAL CHARACTERISTICS

Frequency Range	4.4 to 5.0 GHz
RF Output	2 kw
Diversity	(V)2: Quad or Dual; (V)3: Dual
Bandwidth	(V)2: 3.5 or 6 MHz; (V)3: 3.5 or 7 MHz
Planning Range	(V)2: 241 km (150 mi); (V)3: 161 km (100 mi)
No. of Channels	8 to 144
Data Rates	128 to 4,096 kb/s
Power Requirement	120/208 V AC; 50/60/400 Hz
Weight	(V)2: 3,859 kg (8,500 lb) (with shelter) (V)3: 2,656 kg (5,850 lb) (with shelter)
Shelter	(V)2: Modified S-280/G (V)3: Modified S-250/G
Vehicle Requirement	(V)2: Two 2 1/2-ton trucks (V)3: Two 1 1/4-ton trucks

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
					XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-173
NOMENCLATURE	Radio Terminal Set

ATTRIBUTES

TECHNOLOGY	1. Digital radio terminal set, TRI-TAC
FUNCTION	Provides up to two 18/36 channel digital multichannel LOS systems in a radio or cable terminal mode
CAPABILITIES	1. Air or vehicular transportable 2. Secure radio/cable tactical communications 3. Secure voice orderwire 4. Multiple system deployment
FEATURES	Compatible with INTACS and TRI-TAC
MAJOR COMPONENTS	1. 1ea Shelter S-589 2. 2ea Radio Sets AN/GRC-103(V)4 3. 2ea Trunk Encryption Devices TSEC/KG-81 4. 2ea Trunk Group Multiplexers TD-1236( )/G 5. 4ea Remote Multiplexer-Combiners TD-1234( )/TTC 6. 2ea Remote Loop Group Multiplexer Cable Driver Modems MD-1025( )/G 7. 2ea Low Speed Cable Driver Modems MD-1023( )/G 8. 2ea Digital Data Group Modems MD-1026( )(P)/G 9. 1ea Digital Data Modem MD-1065( )(P)/G 10. 1ea Dedicated Loop Encryption Device TSEC/KG-84 11. 1ea Orderwire Control Unit C-10716 12. 1ea VINSON TSEC/KY-58 13. 1ea Power Supply 28 V DC 14. 2ea Antennas AS-3047/GRC-103 15. 2ea Masts AB-577 16. 2ea Mast Extension Kits MK-806 17. 1ea Intercommunications Station LS-147F/FI 18. 1ea Frequency Electronic Converter CV-2500 19. 2ea Dummy Loads DA-437/GRC-103 20. 1ea Telephone Set TA-312/PT

21. 1ea Headset H-182/PT
22. 1ea DSVT KY-68
23. 1ea ETD KYK-13
24. 1ea Net Control Device KYK-15/TSEC
25. 1ea Fill cable ancillary components and spares
26. 1ea Tape Reader KOI-18
27. 1ea SINCGARS-V Radio Set
28. 1ea Power Unit AN/MJQ-19

TECHNICAL CHARACTERISTICS

Frequency Range	1.35 to 1.85 GHz (Band IV)
RF Output	15 W (Band IV)
Transmission Range	64 km (40 mi)
Cable Driver Modem	8 km
Channelization	Time Division Multiplexing
No. of Channels	8 to 72
Power Requirement	115 V AC, single phase
Weight	2,179 kg (4,800 lb)
Shelter	S-589 (modified S-280/G)
Vehicular Requirement	2 1/2 ton truck

REPLACES

1. AN/TRC-117
2. AN/TRC-151

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
					XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-174
NOMENCLATURE	Radio Repeater

ATTRIBUTES

TECHNOLOGY	1. Digital radio repeater, TRI-TAC
FUNCTION	Radio repeater or split radio terminal
CAPABILITIES	1. Air or vehicular transportable 2. Secure radio/cable tactical communications 3. Multiple system deployment
FEATURES	Compatible with INTACS and TRI-TAC
MAJOR COMPONENTS	1. 3ea Radio Sets AN/GRC-103(V)4 2. 3ea Low Speed Cable Driver Modems MD-1023( )/G 3. 1ea Digital Data Group Modem MD-1026( )(P)/G 4. 1ea Digital Data Modem MD-1065( )(P)/G 5. 2ea Dedicated Loop Encryption Devices TSEC/KG-84 6. 1ea Orderwire Control Unit C-10716 (OCU Type 1) 7. 1ea VINSON TSEC/KY-58 8. 1ea Power Supply 28V DC 9. 3ea Antennas AS-3047/GRC-103 10. 3ea Masts AB-577 11. 3ea Mast Extension Kits CY-4507 12. 1ea Intercommunications Station LS-147F/FI 13. 1ea Frequency Electronic Converters CV-2500 14. 3ea Dummy Loads DA-437/GRC-103 15. 1ea Telephone Set TA-312/PT 16. 1ea Headset H-182/PT 17. 1ea Power Unit AN/MJQ-19 18. Ancillary components and spares 19. 1ea DSVT KY-68 20. 1ea ETD KYK-13 21. 1ea Fill cable 22. 1ea Tape Reader KOI-18 23. 1ea SINCGARS-V Radio 24. 1ea Shelter S-590

AN/TRC-174 (Cont'd)

TECHNICAL CHARACTERISTICS

Frequency Range	1.35 to 1.85 GHz (Band IV)
Transmission Range	64 km (40 mi)
Cable Driver Modem	1.6 km (1 mi) unrepeated
RF Output	15 W (Band IV)
Channelization	Time division multiplexing
No. of Channels	Up to three 18/36 digital multichannel LOS systems
Power Requirement	115 V AC, single phase
Weight	2,134 kg (4,700 lb)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
					XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-175
NOMENCLATURE	Radio Terminal Set

ATTRIBUTES

TECHNOLOGY
1. Shortwave wideband radio (SRWBR)
2. Digital group multiplexing (DGM)

FUNCTION

SRWBR transmission for bottom-of-the hill (BOH) node

CAPABILITIES
1. Transportable
2. Secure radio/cable tactical communications
3. Multiple system deployment

FEATURES

Compatible with ATACS and TRI-TAC

MAJOR COMPONENTS
1. 1ea Shelter S-591/modified S-2
2. 2ea Radio Set AN/GRC-144
3. 2ea Multiplexers TD-1237/G
4. 2ea Cable Driver Modems MD-1024/G
5. 4ea Digital Data Modems MD-1026/G

TECHNICAL CHARACTERISTICS

Frequency Range	4.4 to 5.0 GHz
Transmission Range	8 km at 18.72mb/s; 24 km at 9.36 mb/s
Cable Driver Modem	8 km
RF Output	250 mW
Channelization	Time division multiplexing
No. of Channels	SRWBR 576-channel link

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
					XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-190(V)3
NOMENCLATURE	LOS Multichannel Radio Terminal

ATTRIBUTES

TECHNOLOGY	1.	Digital LOS radio terminal, MSE
FUNCTION		Provides radio implementation at MSE node centers
CAPABILITIES	1.	Air and vehicle transportable
	2.	Implements up to three radio LOS multichannel links
	3.	Secure voice order wire
	4.	Can operate as a radio relay
	5.	One Down-the-Hill (DTH) radio link
FEATURES		Compatible with MSE
MAJOR COMPONENTS	1.	1ea Shelter S-250( )/G
	2.	1ea Orderwire Control Unit OCU-1 C-10716/TRC
	3.	1ea VINSON COMSEC Unit KY-57
	4.	1ea Electronic Transfer Device KYK-13
	5.	1ea Telephone Handset H-350
	6.	3ea LOS Radio Sets AN/GRC-226 (ACT)
	7.	2ea Cable Assemblies CX-11230/G
	8.	3ea LOS Antenna Cables
	9.	1ea Radio and Control Unit (DTH) AN/GRC-224(P)
	10.	1ea Cable Reel (DTH)
	11.	1ea Trunk Group Multiplexer TD-1236/G

TECHNICAL CHARACTERISTICS

Frequency Range	225 to 400 MHz or 1350 to 1850 MHZ (LOS) 14.50 to 15.35 (DTH)
Transmission Range	30 km (LOS) 2 to 5 km (DTH)
Type of Modulation	Group data FSK
Vehicle Requirement	1 1/4 ton M-1037 (HMMWV)

AN/TRC-190(V)3) (Cont'd)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	1	1

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX			

Note: A #1 under the GS/DEP column signifies GFE normal procedures, with MSE unique items returned to GTE at these levels

END ITEM	YES
COMPONENT	NO
MODEL	AN/TRC-191
NOMENCLATURE	Radio Access Unit

ATTRIBUTES

TECHNOLOGY

1. Radio access unit, MSE
2. Digital group multiplexing (DGM)

FUNCTION

Automatic interface between MSE mobile subscribers and the automatic switch network

CAPABILITIES

1. Air and vehicle transportable
2. Eight simultaneous calls
3. Performs full management of the radio channels
4. Connects to the node center switch via LOS radio link or direct cable connection

FEATURES

Compatible with MSE system

MAJOR COMPONENTS

1. 1ea Shelter S-250( )/G
2. 1ea Electronic Transfer Device KYK-13
3. 1ea Radio Frequency Fill Device
4. 1ea Group Logic Unit
5. 1ea Antenna Multicoupler
6. 8ea Radio Transceivers RT-1539
7. 1ea Loop Group Multiplexer TD-1235
8. 1ea Trunk Encryption Device KG-94
9. 1ea Group Modem MD-1026
10. 1ea Orderwire Control Unit
11. 1ea VINSON COMSEC Equipment KY-57
12. 1ea Transition Box
13. 1ea Junction Box
14. 1ea Antenna Mast Mounted
15. 1ea Vehicular Antenna
16. 1ea DSVT KY-68
17. 1ea Antenna Mast

TECHNICAL CHARACTERISTICS

Frequency Range	30 to 35 MHz (low band, CONUS) 40 to 50 MHz (high band, CONUS) 30 to 51 MHz (low band, OCONUS) 50 to 88 MHz (high band, OCONUS)
Transmission Range	15 km
Power Requirements	115 V AC, 50 or 60 Hz, single phase, or 28 V DC
Vehicular Requirement	1 1/4-ton M-1037 (HMMWV)

AN/TRC-191 (Cont'd)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	1	1

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Note: A #1 under the GS/DEP column signifies GFE normal procedures, with MSE unique items returned to GTE at these levels

END ITEM	YES
COMPONENT	NO
MODEL	AN/TSC-85A
NOMENCLATURE	Satellite Communications Terminal

ATTRIBUTES

TECHNOLOGY

1. Tactical satellite terminal
2. Analog and digital multiplexing

FUNCTION

Provide increased range for tactical communications systems

CAPABILITIES

1. Air and vehicle transportable
2. Provide point to point or multi-point operation via satellite
3. Can transmit one and receive up to four high data rate carriers
4. Receive, transmit, and process medium and high capacity multiplexed voice, data, and teletypewriter circuits
5. Using COMSEC equipment process secure and nonsecure traffic

FEATURES

Compatible with MSE and TRI-TAC

MAJOR COMPONENTS

1. 1ea Receiver-Transmitter Orderwire RT-1287/TSC
2. 2ea Radio Frequency Amplifier AM-6701/TSC
3. 2ea Power Supply PP-7712(V)2/TSC
4. 2ea Frequency Converter CV-3198A/TSC
5. 2ea Multiplexer/Demultiplexer (TSSP) TD-1337/(V)1/G
6. 6ea Frequency Converter CV-3201/TSC
7. 5ea Digital Data Modem MD-945/TSC
8. 1ea Telephone Set TA-312/PT
9. 1ea Intercommunications Station LS-147F/FI
10. 1ea Antenna AS-3036A/TSC
11. 1ea Antenna Control C-10237/TSC
12. 4ea Multiplexer TD-1069/G
13. 4ea Security Device TSEC/KG-27
14. 4ea Echo Suppressor MX-9635A/TSC
15. 1ea Fault Alarm BZ-236A/TSC
16. 4ea Multiplexer TD-660B/G
17. 4ea High Speed Data Buffer TD-1065
18. 1ea Group Modem MD-1026
19. 4ea Signal Converter CV-1548A/G
20. 1ea Shelter S-280/G

AN/TSC-85A (Cont'd)

TECHNICAL CHARACTERISTICS

Frequency Range	Receive: 7250 to 7750 MHz Transmit: 7900 to 8400 MHz
Power Output	500 W (nominal) at antenna
Operation	Single Channel (digital voice): 16/32 kb/s Multichannel: 6, 12, 24, 18-96 channels (48 kb/s per channel at true multiplex data rates)
Power Requirements	115 V AC ±10%, 50/60 Hz, 3 phase, 5 wire
Vehicular Requirement	2 1/2 or 5 ton

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX		XXXX	

Note: Select divisions only receive this item

END ITEM	YES
COMPONENT	NO
MODEL	AN/TSC-93A
NOMENCLATURE	Satellite Communications Terminal

ATTRIBUTES

TECHNOLOGY

1. Tactical satellite terminal
2. Analog and digital multiplexing

FUNCTION

Via satellite provide extended range for tactical communications systems

CAPABILITIES

1. Air and vehicle transportable
2. Provide point to point operation via satellite
3. Can transmit and receive one high data rate carrier
4. Receive, transmit, and process medium and high capacity multiplexed voice, data, and teletypewriter circuits
5. Using COMSEC equipment processes secure and nonsecure traffic

FEATURES

Compatible with MSE and TRI-TAC

MAJOR COMPONENTS

1. 1ea Receiver-Transmitter Orderwire RT-1287/TSC
2. 2ea Frequency Converter CV-3201/TSC
3. 1ea Digital Data Modem MD-945/TSC
4. 1ea Radio Frequency Amplifier AM-6701/TSC
5. 1ea Power Supply PP-7712(V)2/TSC
6. 1ea Frequency Converter CV-3189/TSC
7. 1ea Multiplexer/Demultiplexer (TSSP) TD-1337(V)2/TSC
8. 2ea Multiplexer TD-660/G
9. 2ea High-Speed Data Buffer TD-1065/G
10. 2ea Echo Suppressor MX-9635A/TSEC
11. 2ea Converter CV-1548/G
12. 2ea Security Device TSEC/KG-27
13. 1ea Multiplexer TD-1069/G
14. 1ea Telephone Set TA-312/PT
15. 1ea Intercommunications Station LS-147F/FI
16. 1ea Antenna AS-3036A/TSC
17. 1ea Antenna Control C-10237/TSC
18. 1ea Shelter S-250/G

TECHNICAL CHARACTERISTICS

Frequency Range	Receive: 7250 to 7750 MHz Transmit: 7900 to 8400 MHz
Power Output	500 W (nominal) at antenna
Operation	Single Channel (digital voice): 16/32 kb/s Multichannel: 6, 12, 24, 18-96 channels (48 kb/s per channel at true multiplex data rate)
Power Requirements	115 V AC ±10%, 50/60 Hz ±5% 3-phase, 5-wire, 5500 W (nominal)
Organic Power	PU-753 (two each)
Vehicular Requirement	2 1/2-ton truck (two each)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX		XXXX	

Note: Select divisions only receive this item

END ITEM	YES
COMPONENT	NO
MODEL	AN/TTC-39A(V)1
NOMENCLATURE	Automatic Telephone Central Office

ATTRIBUTES

TECHNOLOGY

1. Hybrid circuit switch, TRI-TAC

FUNCTION

Provides network interface for subscriber access

CAPABILITIES

1. Air and vehicle transportable
2. Provides secure automatic switching and technical control for both analog and digital communications
3. The facility provides technical control functions including channel reassignment and multiplexing, line testing, engineering orderwire, atomic timing standard, and analysis or trouble reports, alarms, and system data
4. Signals and supervises analog and digital trunks and lines
5. Signaling includes 20Hz/1600 Hz ringdown, DC closure, dial pulse, DTMF/multifrequency, and 6-wire E&M using tone burst, confirmation, noconfirmation, common channel, and DIBITS
6. Performs central processing and operator interface functions

FEATURES

1. Compatible with TRI-TAC and interfaces with MSE
2. Man/machine interface via keyboard VDU's and printer.

MAJOR COMPONENTS

1. 1ea Switching Module Assembly in Shelter S-280B/G (Modified)
2. 1ea Storage Shelter S-640
3. 1ea Maintenance Shelter S-640
4. 1ea Master Power Distribution Unit ON-224T
5. 2ea PU-406 Electric Power Units (30 kw) AN/MJQ-10A

AN/TTC-39A(V)1 (Cont'd)

TECHNICAL CHARACTERISTICS

Total External Lines	744
Digital Matrix	648
Analog Matrix	96
Maximum Local Loops/ Trunks (within this total)	240
Digital Local Loops	144
Analog Local Loops/ Trunks	96
Maximum Analog Loops via DTGs	60
Switch Rate	16/32 kb/s
Total DTGs	30
Maximum Analog Loops via DTGs	144
In-Band Digital Trunks (Long Loops)	200
Call Rate	7,500 (calls per busy hour)
Analog Bandwidth	108 kHz
Numbering Plan	TRI-TAC NATO, 13 digits; military tactical , 7 digits; AUTOVON, 10 digits
Power Requirements	120/208 V AC 50, 60, 400 Hz, three-phase
Vehicle Requirements	One 5-ton truck (TTC-39A) One 2 1/2-ton truck (S-640) One 2 1/2-ton truck (S-639)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
					XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TTC-41( )
NOMENCLATURE	Automatic Telephone Central Office

ATTRIBUTES

TECHNOLOGY

1. Automatic switching

FUNCTION

Provide rapid automatic switching to tactical units in an area type communications system

CAPABILITIES

1. Air or vehicular transportable
2. Provides cordless service to 2-wire common battery signaling lines, 20 Hz ringdown lines or trunks, common battery dial pulse or DTMF lines, and 4-wire tone signaling trunks
3. Provides non-secure service only
4. Provides 30 to 120 circuits based on model

FEATURES

Compatible with ATACS and INTACS

MAJOR COMPONENTS

1. 1ea Shelter S-561/TTC-41( ) (modified Shelter S-250/G) ((V)1-(V)4 models)
2. 1ea Trailer Assembly, V-498/TTC-41(V) (modified trailer M-569) ((V)5-(V)7 models)
3. 1ea Intercommunications Station LS-147F/FI (all models)
4. 1ea Telephone Set TA-938/G pushbutton (all models)
5. 1 through 5ea Switchboards SB-3614(V)/TT or SB3614A(V)/TT, and Headset H-182/PT (depending on the model)
6. 1 or 2ea Power Supplies PP-6224/U (depending on the model)
7. 1ea headset switchbox (all models)

TECHNICAL CHARACTERISTICS

Lines or Trunks	
AN/TTC-41(V)1	30 (shelter configuration)
AN/TTC-41(V)2	60 (shelter configuration)
AN/TTC-41(V)3	90 (shelter configuration)
AN/TTC-41(V)4	120 (shelter configuration)
AN/TTC-41(V)5	60 (trailer configuration)

AN/TTC-41(V)6	90 (trailer configuration)
AN/TTC-41(V)7	120 (trailer configuration)
Power Consumption and weight	
AN/TTC-41(V)1	5.1 kw, 1,031 kg (2,270 lb)
AN/TTC-41(V)2	5.2 KW, 1,058 kg (2,230 lb)
AN/TTC-41(V)3	5.3 kw, 1,090 kg (2,400 lb)
AN/TTC-41(V)4	6.5 kw, 1,167 kg (2,570 lb)
AN/TTC-41(V)5	2.1 kw, 945 kg (2,080 lb)
AN/TTC-41(V)6	2.2 kw, 963 kg (2,120 lb)
AN/TTC-41(V)7	3.5 kw, 1,050 kg (2,310 lb)
Vehicle Requirement	
AN/TTC-41(V)1-(V)4	One 1 1/4-ton truck
AN/TTC-41(V)5-(V)7	One 1/4-ton truck and 3/4-ton trailer

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX	XXXX	XXXX	XXXX		XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/TTC-47
NOMENCLATURE	Node Center Switch

ATTRIBUTES

TECHNOLOGY	1. Digital automatic electronic switch, MSE
FUNCTION	Provides network interface for subscriber access
CAPABILITIES	1. Air and vehicle transportable 2. Provides automatic subscriber finding features 3. Performs central processing and operator interface functions 4. Provides external interface, circuit switching, and associated functions 5. Provides secure circuits
FEATURES	Compatible with MSE and interfaces with TRI-TAC
MAJOR COMPONENTS	1. 1ea Shelter S-250/G 2. 1ea Shelter S-250E/G 3. 1ea Switch Subsystem AN/TTC-47: 4. 1ea LCSP 5. 1ea Switching Processor System 6. 1ea Plasma Display Unit 7. 2ea MTU 8. 2ea TDSGM 9. 15ea Trunk Encryption Device KG-94 10. 16ea Loop Key Generator KG-82 11. 2ea Automatic Key Distribution Control KGX-93 12. 2ea Transition Unit HGF-93 13. 1ea Net Control Device KYX-15 14. 1ea Orderwire Control Unit 15. 1ea VINSON COMSEC KY-57 16. 1ea Environmental Control Unit 17. 2ea Junction Box J-1077/U 18. 1ea Intercommunications Station LS-147 19. 1ea Communications Terminal AN/UGC-74B 20. 1ea DNVT TA-1035/U 21. 2ea Signal Cable CX-4566

22. 6ea Intershelter Cables
23. 1ea Power Cables CX-7453 and CX-7705

TECHNICAL CHARACTERISTICS

Power Requirements	115 V AC, 50 or 60 Hz, single phase
Channel Rates	16 kb/s
Digital Terminations	648
Trunk Signaling Buffers	8
Digital Inband Signaling Buffers	10
Digital Transmission Group	16
Digital Receivers	20
Digital Loops	24
Analog Interfaces (STANAG 5040)	8
Conference Bridge Units	4 (20 ports)
Vehicular Requirements	Two 1 1/4 ton M-1037 (HMMWV)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	1	1

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX			

Note: A #1 under the GS/DEP column signifies GFE normal procedures, with MSE unique items returned to GTE at these levels

END ITEM	YES
COMPONENT	NO
MODEL	AN/TTC-48(V)
NOMENCLATURE	Small Extension Node Switch

ATTRIBUTES

TECHNOLOGY

1. Digital automatic electronic switch, MSE
2. DGM multiplexing

FUNCTION

Support the secure digital communications of a Command Post

CAPABILITIES

1. Air or vehicular transportable
2. Comprised of switching, multiplexing, and COMSEC equipment
3. Provides normal subscriber access point for entry into the MSE network
4. Provides (when equipped with KY-90) Net Radio Interface for FM radio users into the MSE network
5. Secure voice orderwire
6. Interfaces with a LENS or NC switch directly via CX-11230/G cable, via LOS or via TACSAT Terminal AN/TSC-85A or AN/TSC-93A

FEATURES

Compatible with MSE and TRI-TAC

MAJOR COMPONENTS

1. 1ea Shelter S-250( )/G
2. 2ea Telephone Switchboards SB-4303
3. 1ea DNVT TA-1035/U
4. 1ea Loop Group Multiplexer TD-1235
5. 1ea Trunk Encryption Device KG-94
6. 1ea Group Modem MD-1026
7. 1ea Orderwire Control Unit
8. 1ea VHF Radio Set AN/GRC-224(P)
9. 1ea VINSON COMSEC Equipment KY-57
10. 1ea Secure Digital Net Radio Interface Unit KY-90 (one in three)
11. 1ea Transition Unit HGF-94
12. 1ea Inverter Avionics
13. 1ea Environmental Control Unit
14. 2ea Junction Boxes J-1077/U ((V)1)
15. 4ea Junction Boxes J-1077/U ((V)2)
16. 2ea Cables CX-4566 (250 feet) ((V)1)
17. 4ea Cables CX-4566 (250 feet) ((V)2)

AN/TTC-48(V) (Cont'd)

TECHNICAL CHARACTERISTICS

Digital Lines or Trunks	
AN/TTC-48(V)1	26 lines, 10 trunks
AN/TTC-48(V)2	41 lines, 13 trunks
DC Closure Commercial Office Interface Lines	2
Vehicular Requirement	One 1 1/4-ton truck M-1037 (HMMWV)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	1	1

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX		XXXX	

Note: A #1 under the GS/DEP column signifies GFE normal procedures, with MSE unique items returned to GTE at these levels

END ITEM	YES
COMPONENT	NO
MODEL	AN/TTC-65
NOMENCLATURE	Telephone Terminal

ATTRIBUTES

TECHNOLOGY

1. PCM telephone terminal
2. Analog multiplexers

FUNCTION

Provide multiplexing for radio terminals lacking this capability

CAPABILITIES

1. Air or vehicular transportable
2. Provides four 12-channel or two 24-channel 2-wire/4-wire voice secure/nonsecure analog telephone systems
3. Non-secure orderwire

FEATURES

Compatible with ATACS

MAJOR COMPONENTS

1. 1ea Shelter S-333/TCC-65 (modified S-250/G)
2. 4ea Converters CV-1548/G
3. 4ea Multiplexers TD-754
4. 4ea Multiplexers TD-660( )/G
5. 1ea Telephone Set TA-312/PT
6. 4ea Communications Security Equipment TSEC/KG-27
7. 1ea Intercommunications Station LS-147F/FI

TECHNICAL CHARACTERISTICS

Power Requirement	115 V AC, 50 to 60 Hz
Power Consumption	4,090 W
Weight	591 kg (1,302 lb)
Vehicular Requirement	One 1 1/4-ton truck

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX			XXXX		XXXX

END ITEM	YES
COMPONENT	NO
MODEL	AN/TYC-39
NOMENCLATURE	Automatic Message Switch

ATTRIBUTES

TECHNOLOGY	1. Computer controlled automatic message switch
FUNCTION	Provide secure, automatic message switching of narrative record and data traffic
CAPABILITIES	1. Air and vehicle transportable 2. Processes multiple and collective addressed messages 3. Performs mode, code, speed, and format conversions 4. Handles six levels of message precedence 5. Performs message retrieval for retransmission, and message accountability and service functions 6. Interfaces with: currently fielded record traffic terminals, MRTT, MTCC, ULMS, Automatic Telephone Central Office AN/TTC-39( ), and DCS AUTODIN I 7. Serves R, U, and Y communities 8. Fielded in 25 or 50 line versions
FEATURES	Compatible with MSE, TRI-TAC, and DCS AUTODIN
MAJOR COMPONENTS	1. 1 to 3 Shelters S-280/G modified 2. 1ea Maintenance Shelter S-639 (stand alone switch only) 3. 1ea Parts/Storage Shelter S-640 4. 1ea ADP group 5. 1ea Central Processor Group 6. 2ea Magnetic Tape Transfer Units (MTT) 7. 1ea Line Printer 8. 2ea Visual Display Units (VDU) 9. 1ea Power Control Group 10. 1ea Black and Red Patch Panels 11. COMSEC Equipments 12. 1ea Telephone Set DSVT TA-341

AN/TYC-39(V) (Cont'd)

13. 1ea Intercommunications Station LS-147F/FI
14. 1ea DC/AC Inverter
15. 1ea Battery Bank (backup power)
16 2ea Power Processors
17. 1ea RASU
18. 1ea ICU
19. 1ea ECU and ECU Control
20. DC/AC Converters

TECHNICAL CHARACTERISTICS

Message Formats — Automatically accepts, processes, stores, delivers and accounts for narrative and data traffic in:
ACP 127 and ACP 127 modified or JANAP 128 and JANAP 128 modified formats.

Power Requirement — 115/208 V AC, 3-phase, 50/60 Hz (400 Hz (V)4 only)

Vehicle Requirements — 25 Line Switch: one 5-ton truck
50 Line Switch: two 5-ton trucks
OX-54 (if issued): one 5-ton truck
S-639 Maintenance Shelter: one 2 1/2-ton truck
S-640 Part/Storage Shelter: one 2 1/2-ton truck

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
			XXXX		XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/TYQ-30(V)1
NOMENCLATURE	Communications System Control Element

ATTRIBUTES

TECHNOLOGY

1. Automated TRI-TAC network management system
2. DGM multiplexing

FUNCTION

Provides automated management and systems control of TRI-TAC networks

CAPABILITIES

1. Air and vehicular transportable
2. Provides the EAC network manager automated management facilities for planning the allocation, use, and operation of the deployed tactical communications network
3. An extensive network database monitors the network's status through reports received from subelements
4. An automated facility for preparing and disseminating operations orders, telecommunications service orders, contingency plans, and other documents

FEATURES

Compatible with TRI-TAC

MAJOR COMPONENTS

AN/TYQ-30(V)1 (ADP Shelter)

1. 3ea Micro VAX II Computers
2. 6ea 175-MB Disk Drives
3. 2ea Workstation VS-2000
4. 1ea Matrix Printer
5. 1ea VHF Radio VRC-46 or VRC-90 with KY-57
6. 10ea DSVT KY-68
7. 1ea Facsimile AN/UXC-7
8. 2ea Fiber Optic Extender
9. 1ea Multiport Repeater
10. 8ea DSDI
11. 1ea Loop Group Multiplexer TD-1235(P)/TTC
12. 1ea Intercommunication Station LS-147F/FI
13. 1ea Shelter S-280(C)/G

AN/TYQ-30(V)1 (Operations Shelter)

14. 4ea Workstation VS-2000

15. 1ea VHF Radio VRC-46 or VRC-90 with KY-57
16. 4ea DSVT KY-68
17. 1ea Facsimile AN/UXC-7
18. 1ea Fiber Optic Extender
19. 1ea Remote Terminal Cluster
20. 1ea Shelter S-280(C)/G

TECHNICAL CHARACTERISTICS

Power Requirement	120/208 V AC, ±6% to -12%, 50/60 Hz ±3%, 3-phase
Organic Power	AN/MJQ-10 (2 ea 30 kw)
Prime Mover	Two 5-ton trucks M-923
Weight	2,863 kg (6,300 lb) (ADP Shelter) 2,727 kg (6,000 lb) (Operations Shelter)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
					XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	AN/UGC-74()
NOMENCLATURE	Terminal Communications

ATTRIBUTES

TECHNOLOGY	1.	Bit serial data communications
FUNCTION		Used to compose, edit, store, transmit, receive, and print army record traffic communications
CAPABILITIES	1.	ITA2 (Baudot) code
	2.	ASCII code
FEATURES	1.	Interface/operate w/existing and post 1980 communications/COMSEC equipment
	2.	Mode of transmission - asynchronous or synchronous (dependent on data rate)
MAJOR COMPONENTS	N/A	

TECHNICAL CHARACTERISTICS

Range	3.2 km under worst conditions
Type of Operation	Local or common-battery
Signaling (outgoing)	900 to 3400 Hz DTMF
Signaling (incoming)	90 V AC, 20 Hz
Type of Signal	Audible tone, adjustable volume
Power Requirements	6 V DC
Weight	3.6 kg

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

END ITEM	YES
COMPONENT	YES
MODEL	AN/UXC-7
NOMENCLATURE	Tactical Digital Facsimile Set

ATTRIBUTES

TECHNOLOGY

1. Digital electronic facsimile

FUNCTION

Electronic transmission/reception of documents containing black and white, color, or gray shades.

CAPABILITIES

1. Will operate over existing and proposed standard voice radios and wire circuits
2. Will operate using standard or vehicular power
3. Full digital or analog data/voice capability
4. Data is stored in memory prior to transmission
5. High-speed "burst" transmission reduces chance of detection

FEATURES

1. Lightweight
2. Rugged
3. Portable
4. Low power
5. Waterproof

MAJOR COMPONENTS N/A

TECHNICAL CHARACTERISTICS

Printing	Any paper, using carbon paper transfer, transparencies, map overlays, and view graphs
Power Requirements	115/230 V AC, 47 to 420 Hz or 22 to 32 V DC, 50 W
Power Consumption	55 W AC standby; 98 W DC operating
Weight	24.9 kg including carrying case

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

AN/UXC-7 (Cont'd)

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX		

END ITEM	YES
COMPONENT	NO
MODEL	AN/VRC-97
NOMENCLATURE	Mobile Subscriber Radiotelephone Terminal

ATTRIBUTES

TECHNOLOGY

1. MSE cellular phone
2. Secure Voice

FUNCTION

Provides mobile subscribers access to the MSE switched network

CAPABILITIES

1. Installed in vehicles or ground mount
2. Radio interface at 16 kb/s to the DSVT which provides secure discrete addressability
3. Radio front panel operator accessible to the user for inserting the COMSEC crypto-variable and frequency fill
4. Personal code and directory number is completed by using the keypad on the DSVT
5. Once initiated, the radio operates completely automatically, all subsequent calls, both initiating and answering, need only use the DSVT

FEATURES

1. Compatible with MSE
2. Rugged construction, no environmental protection required

MAJOR COMPONENTS

1. 1ea VHF Radio RT-1539(P)
2. 1ea Digital Secure Voice Terminal KY-68
3. 1ea Antenna, VHF (30 to 88 MHz)
4. 1ea Electronic Transfer Device KYK-13

TECHNICAL CHARACTERISTICS

Power Requirements	110 V AC, 220 V AC, or 28 V DC
Power Consumption	50 W (stand by) 240 W (maximum call-in-process)
Frequency Range MSRT transmits in low band and receives in high band	30 to 35 MHz (low band, CONUS) 40 to 50 MHz (high band, CONUS) 30 to 51 MHz (low band, OCONUS) 59 to 88 MHz (low band, OCONUS)
Transmission Range	15 km

AN/VRC-97 (Cont'd)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	1	1

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX		

Note: A #1 under the GS/DEP column signifies GFE normal procedures, with MSE unique items returned to GTE at these levels

END ITEM	YES
COMPONENT	NO
MODEL	AT-784/PRC
NOMENCLATURE	Loop Antenna

ATTRIBUTES

TECHNOLOGY

1. FM radio signal direction finder

FUNCTION

Enables the operator to determine the direction of a transmitted radio signal

CAPABILITIES

1. Reception only

FEATURES

1. Used in conjunction with FM radio sets:
   AN/PRC-77 AN/VRC-12

MAJOR COMPONENTS

1. Antenna AT-1082/PRC
2. Cable Assembly Radio Frequency CG-3344/PRC (5 ft)
3. Cable Assembly Radio Frequency CG-2840/U (12 ft)
4. Bag Cotton Duck CW-445/PRC

TECHNICAL CHARACTERISTICS

Frequency Range	30 to 76 MHz covered in 5 bands
Planning Range	Depends on the radio set used
Weight	1.1 kg

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX						

END ITEM	YES
COMPONENT	NO
MODEL	OE-303
NOMENCLATURE	Half-Rhombic VHF Antenna

ATTRIBUTES

TECHNOLOGY
1. VHF antenna

FUNCTION

Provides VHF radio sets with directional operating capability

CAPABILITIES
1. Provides a directional transceiver station
2. Oriented using compass and map sheet

FEATURES
1. High Gain
2. Lightweight
3. Ancillary equipment contained in two carrying bags
4. Radio set connectors and cables provided with antenna

MAJOR COMPONENTS
1. Mast Assembly AB-1244

TECHNICAL CHARACTERISTICS

Frequency Range	30 to 88 MHz
Antenna Erection Time	20 minutes (two persons)
Height Erected	9.1 m (30 ft)
Weight	20.4 kg (45 lb)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

END ITEM	YES
COMPONENT	NO
MODEL	OL-415/TYQ-35(V)
NOMENCLATURE	System Control Group, Technical

ATTRIBUTES

TECHNOLOGY

1. MSE, automated network management
2. DGM multiplexing

FUNCTION

Provides the System Control Center (SCC) processor functions

CAPABILITIES

1. Air and vehicular transportable
2. Provides the processing suite for the SCC (processor, memory, disk memory, magnetic tape, drives, and control unit)
3. Provides the network communications interface equipment for the SCC
4. Performs all of the processor functions required of the SCC

FEATURES

Compatible with MSE

MAJOR COMPONENTS

1. 1ea Shelter S-250( )/G
2. 1ea Environmental Control Unit
3. 1ea DNVT TA-1035/U
4. 1ea Central Processor Unit
5. 1ea Input/Output Unit
6. 1ea Magnetic Disk
7. 2ea Magnetic Tape Transporters
8. 2ea Communications Terminals AN/UGC-74B
9. 1ea Control Panel
10. 1ea Intercommunications Station LS-147
11. 1ea Loop Group Multiplexer TD-1235
12. 1ea Group Modem MD-1025
13. 1ea Automatic Key Distribution Center KGX-93
14. 1ea Transition Unit Nest Assembly HGF-93
15. 1ea Net Control Device KYX-15

TECHNICAL CHARACTERISTICS

Power Requirements	115 V AC, 50 or 60 Hz, single phase
Prime Mover	One 1 1/4-ton truck M-1037 (HMMWV)

OL-415/TYQ-35(V) (Cont'd)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX			

END ITEM	YES
COMPONENT	NO
MODEL	SB-22/PT
NOMENCLATURE	Manual Telephone Switchboard

ATTRIBUTES

TECHNOLOGY

1. Manual switchboard

FUNCTION

Field facilities for:
- Local-battery telephone circuits
- Remote controlled radio circuits
- Teletypewriter circuits

CAPABILITIES

1. Can be configured for:
   - One-way ringdown
   - One-way automatic trunk circuits with any other switchboard with common battery signaling
2. Tone-signaling Adapter provides 2-wire push-button tone-signaling for interfacing automatic switches

FEATURES

1. Rapid installation
2. Can be stacked

MAJOR COMPONENTS

1. 1ea Telephone Circuit Operators TA-221/PT
2. 12ea Telephone Circuits Line Jack TA-222/PT
3. Handset/Headset H-81A/U
4. Tone Signaling Adapter TA-977/PT

TECHNICAL CHARACTERISTICS

Type of Operation	Manual with local battery
Line Capacity	12 (single board) 29 (stacked boards)
Signaling (outgoing)	90 to 100 V AC, 20 Hz
Signaling (outgoing) w/adapter	DTMF
Signaling (incoming)	90 V AC, 20 hz
Type of Signal	Audible or visual alarm
Power Requirements:	
Talking Circuit	3 V DC (two BA-30's)
Night Alarm/Panel Light	3 V DC (two BA-30's)
Weight	15.4 kg (34 lb)

SB-22/PT (Cont'd)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

END ITEM	YES
COMPONENT	YES
MODEL	TA-1035/U
NOMENCLATURE	Telephone Digital Nonsecure Voice (DNVT)

ATTRIBUTES

TECHNOLOGY

1. Prime subscriber terminal, MSE

FUNCTION

1. Provides a data port for interfacing select data devices to the MSE network

CAPABILITIES

1. Full-duplex, conditioned, diphase digital voice and loop signaling information with wire and mobile access equipment

FEATURES

1. Provides supervisory, clock, plain text, and voltage reference signals with data devices
2. Operates in common-battery mode, with power derived from the switch line termination circuit
3. Interfaces with:
   SST AN/UXC-7

MAJOR COMPONENTS N/A

TECHNICAL CHARACTERISTICS

Power Requirements	48 V DC
Power Consumption:	
Off-Hook (Powered up)	1.5 W (maximum)
On-Hook (Powered Down)	300 mW (maximum)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX		

END ITEM	YES
COMPONENT	NO
MODEL	TA-838/TT
NOMENCLATURE	Telephone Set

ATTRIBUTES

TECHNOLOGY
1. DTMF tone signaling

FUNCTION

Field telephone designed for use with switchboards

CAPABILITIES
1. 2 or 4 wire mode

FEATURES
1. Rugged
2. Solid state
3. Interfaces with:

SB-3614/TT	SB-3614/AT
AN/TTC-25	AN/TTC-38
AN/TTC-39	AN/TTC-39A
TA-341/TT	C-6709

MAJOR COMPONENTS N/A

TECHNICAL CHARACTERISTICS

Range	3.2 km (2 mi) from SB-3614/TT under worst conditions
Type of Operation	Local- or common-battery
Signaling (outgoing)	900 to 3400 Hz DTMF
Signaling (incoming)	90 V AC, 20 Hz
Type of Signal	Audible tone, adjustable volume
Power Requirements	6 V DC
Weight	3.6 kg (8 lb)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX		XXXX	

END ITEM	YES
COMPONENT	NO
MODEL	TS-3647( )/G
NOMENCLATURE	Telephone Test Set Cable Orderwire Unit

ATTRIBUTES

TECHNOLOGY

1. Digital group multiplexer (DGM)

FUNCTION

Provides field maintenance of the DGM high speed and low speed cable systems

CAPABILITIES

1. The cable orderwire unit (COU) allows access to the cable system maintenance orderwires, monitors, and the low and high speed conditioned diphase signals
2. Performs measurement of the PR power feed current
3. Field measurement of cable link parameters and internal battery conditions

FEATURES

Used in conjunction with:

CDM	RLGM
RMC	RLGM/CD
GM	LSPR
HSPR	

MAJOR COMPONENTS N/A

TECHNICAL CHARACTERISTICS

Cable Links	Up to 64.3 km
Cable link analog orderwire	Half duplex voice and signaling
Cable Voltage	0 to 1,000 V DC range
Prime Power:	
Type	9 V DC (2 batteries BA-5599( )/U)
Voltage	18 V DC
Weight	11.3 kg (24.2 lb)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

TS-3647( )/G (Cont'd)

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX		XXXX	

END ITEM	YES
COMPONENT	YES
MODEL	TSEC/KY-68
NOMENCLATURE	Digital Subscriber Voice Terminal (DSVT)

ATTRIBUTES

TECHNOLOGY
1. Digital full or half-duplex voice/data subscriber terminal

FUNCTION
1. Encrypting/Decrypting voice traffic
2. Secure digitized data traffic

CAPABILITIES
1. Secure and nonsecure access to the switched networks
2. Secure access to nonswitched networks
3. Provides digital communications interface with TRI-TAC and MSE switches

FEATURES
1. Five-position function switch
2. Audio & ring volume controls
3. Ring/busy extension
4. Nonsecure warning indicators

MAJOR COMPONENTS
1. Handset H-350/U
2. Auxillary Power Supply HYP-71/TSEC

TECHNICAL CHARACTERISTICS

Channel Interface- Field Wire	4-wire, field cable
Power Requirements	-21 to -56 V DC
Weight	6.3 kg (14.0 lb)

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Appendix B. Equipment Domains Assessment Procedure (EDAP)

This appendix contains all parts of the EDAP. Pages B-2 through B-9 contain the "Instruction Packet" of the EDAP. Sample data sheets have been provided as part of this packet to illustrate the concept of describing equipment items solely in terms of attribute values. The remaining pages of the appendix contain the "Domain Cover Sheets" for parts A and B, the post-task questionnaire, and the instructions and "Cover Sheets" for part D of the EDAP. Each of these parts is titled accordingly.

Equipment Domains Assessment Procedure

We are going to ask you, as an expert, to perform an activity in which you will;

1) Assess the attributes of various equipment items;

2) Develop criteria for sorting the sample of equipment items, and;

3) Place related equipment items into groups based on the criteria you develop.

Because of your experience in working with new equipment systems, you are being asked to help identify the equipment attributes that are most critical in determining the degree of relatedness amongst various Signal Branch equipment items. You are asked to imagine that all the items in the sample are newly procured items, and that your mission is to effectively sort and group the items for the most efficient development of training programs and MOS assignments. The tool you are going to use is the Equipment Domains Assessment Procedure (EDAP). The EDAP is a methodology designed to provide a "Hands On" enactment of the above stated mission scenario. This will encourage the participants to rely on their individual expertise so that the process and strategies used in such an action can be recorded and evaluated.

This Instruction Packet contains the following items:

- **Instructions** - The EDAP will be administered in four separate parts. Instructions are provided for each of the four parts.

- **Attribute Definitions** - Operational definitions are provided for a defined set of equipment-related attributes. This set of attributes is used to describe the sample of Signal Branch Equipment items, presented in the next section of this packet.

- **Signal Branch Equipment Sample** - 39 sample items are presented without model numbers or Joint Electronics Type Designation. The items are instead described in terms of the attributes defined in the previous section. Each item in the sample is described in terms of the entire set of attributes. Each page reflects a separate and distinct end item. All data to be utilized during the assessment and sorting of the sample items are provided in this section.

INSTRUCTIONS

Equipment Domains Assessment: Part A

The first task you are asked to preform involves an assessment of the various Signal Branch Equipment items in terms of **Operations** criteria. Operations criteria refer to those considerations directed toward assuring that all operational functions are performed efficiently, safely, and accurately, with minimum requirements for additional personnel, skills, special tools, training, and cost.

Working as a panel, you are to carefully examine the loose data sheets provided by the investigator. These data sheets are identical to the data sheets located in the instruction packet. From this examination you are asked to sort the equipment items based on your knowledge and expertise regarding Signal Branch equipment systems. For each group you create, you are asked to develop a descriptive title and criteria for inclusion in that group. Record this information on a "Domain Cover Sheet" (provided by the investigator) for each equipment group created. Feel free to refer to the Attribute Definitions located in the instruction packet at any time. If you have any questions, please feel free to ask the investigator at any time.

NOTE

The panel is free to develop and use their own methodology to evaluate the equipment sample data sheets. However, it is suggested that a complete set of data sheets be spread out over a conference table to compare, contrast, and sort, prior to clustering the items into groups. The equipment groups should then be carefully reviewed to ensure that the items within a given cluster meet the criteria stated on the Domain Cover Sheet for that equipment group. The panel is then to take a short break.

Equipment Domains Assessment: Part B

Following a short break, (to allow the participants to focus on the next task) the panel is to repeat the above exercise in regard to **Maintenance** criteria, utilizing a new set of data sheets. Maintenance criteria refer to those considerations directed toward assuring that all necessary maintenance is performed effectively, safely, and accurately, with minimum requirements for additional personnel, skills, special tools, training and cost.

Questionnaire: Part C

Following parts A and B of the Equipment Domains Assessment, each member of the panel is to fill out a separate questionnaire (provided by the investigator) as completely as possible. The purpose of the questionnaire is to provide a structured format from which to acquire additional subjective data regarding the first two parts of this instrument.

Equipment Domains Assessment: Part D

Instructions and materials for the completion of this task will be provided by the investigator, following the completion of the questionnaire. Part D represents an extension of Parts A and B.

ATTRIBUTE DEFINITIONS

Technology(s) -	Defines the major type(s) of technology utilized by the end item.
Function(s) -	Defines the principal purpose of the end item. There may be several principal functions of a given end item.
Capabilities -	Defines those aspects of the item which further define the item's function. For example, if an items function is that it is used to compose, edit, and transmit print material, it may have the **capability** to do this in ITA2 or ASCII code.
Features -	Defines those aspects of the item which contribute to the efficient operation of the item (i.e., lightweight, portable, unique interfaces, equipment links, etc.).
Major Components -	Lists the major components of the end item which are required to meet the end item's mission.
Technical Characteristics -	Defines those unique characteristics of the end item which impact the ultimate functionality of the item or system (i.e., type of signal, frequency range, power requirements, weight, transmission range, etc.).
Maintenance Levels -	Defines the levels of maintenance and the intended maintenance channels to be used to maintain a given item.
Organizational Location -	Defines the location of the end item within the Army force structure (i.e., at Echelons above Corp, Division, etc.).

SIGNAL BRANCH EQUIPMENT SAMPLE

EQUIPMENT ITEM #1

ATTRIBUTES

TECHNOLOGY
1. HF-SSB radio set
2. Used with SSB RATT

FUNCTION
Mobile link in a HF communications network

CAPABILITIES
1. Vehicular mounted
2. Secure radio communications

FEATURES
Compatible with standard AM radios

MAJOR COMPONENTS
1. Receiver Transmitter RT-662/GRC or RT-834/GRC
2. Amplifier AM-3349/GRC

TECHNICAL CHARACTERISTICS

Frequency Range	2.0 to 29.999 MHz (AN/GRC-106) 2.0 to 29.9999 MHz (AN/GRC-106A)
Planning Range	Ground wave, 80 km (50 mi) Sky wave, 160 to 2,400 km (100 to 1,491 mi)
Number of Channels	RT-662: 28,000, spaced every 1 kHz RT-834: 280,000, spaced every 100 Hz
RF Output	400 W PEP
Antenna	4.57m (15 ft) whip, or doublet AN/GRA-50
Security Device	TSEC/KY-65
Power Input	27 V DC

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORP	EAC SIG BDE	EAC
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

EQUIPMENT ITEM #2

ATTRIBUTES

TECHNOLOGY	1.	IHFR system
FUNCTION		Mobile link in an HF communications network
CAPABILITIES	1.	Vehicular mounted
	2.	Secure radio and data communications
FEATURES		Compatible with IHFR family
MAJOR COMPONENTS	1.	Receiver-Transmitter RT-1209
	2.	Amplifier-Converter AM-6879
	3.	Amplifier, Radio Frequency AM-6545
	4.	Coupler, Antenna CU-2064
	5.	Mount, Electrical Equipment MT-() GRC 193
	6.	Handset H-189/GR

TECHNICAL CHARACTERISTICS

Frequency Range	2 to 30 MHz Separation 100 Hz channel
Planning Range	Ground wave, 80 km (50 mi) Sky wave, 160 to 2,400 km (100 to 1,491 mi)
Number of Channels	280,000
RF Output	400 W PEP
Antenna	4.57m (15 ft) whip, or doublet AN/GRA-50
Security Device	TSEC/KY-65
Power Input	27 V DC

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	YES	YES

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
XXXX		XXXX		XXXX		XXXX

EQUIPMENT ITEM #3

ATTRIBUTES

TECHNOLOGY	1.	MSE DTH
FUNCTION		Provides intra-nodal connectivity between switches.
CAPABILITIES	1.	Throw-on-the-ground component or mounted in TRC-190(V)( )
	2.	Secure radio communications link
FEATURES		Compatible with MSE
MAJOR COMPONENTS	1.	1ea Control Unit
	2.	1ea RF Unit
	3.	1ea Antenna

TECHNICAL CHARACTERISTICS

Frequency Range	14.50 to 15.35 GHz
Transmission Range	2 to 5 km
Power Input	28 V DC
TDM Data Rates	256, 512, 1024, and 2048 kb/s

MAINTENANCE LEVELS

OPR	ORG	DS	GS	DEP
YES	YES	YES	1	1

ORGANIZATIONAL LOCATION

MVR BN	DIV SIG BN	DIV	CORPS SIG BDE	CORPS	EAC SIG BDE	EAC
	XXXX		XXXX			

Note: A #1 under the GS/DEP column signifies GFE normal procedures, with MSE unique items returned to GTE at these levels.

PART A: OPERATIONS

DOMAIN COVER SHEET

DOMAIN ____

Title:____

Criteria for Inclusion:

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____
8. ____
9. ____
10. ____

PART B: MAINTENANCE

DOMAIN COVER SHEET

DOMAIN ____

Title: ____

Criteria for Inclusion:

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____
8. ____
9. ____
10. ____

PART C: QUESTIONNAIRE

Panelist Information:

Your responses on this questionnaire are anonymous. However, we need some specific information on your U.S. Army background and experience.

1. How long have you been with the New Systems Training Group?______

2. What is your current Grade? ______

3. What is your Title? __________________________________

4. Are you currently on active duty? YES NO

If YES,...

4a. How many years of service?______

4b. What branch?______

4c. What is your MOS/AOC?______

5. If you are <u>not</u> currently on active duty, do you have any related military experience?

YES NO

If YES,...

5a. How many years of service?______

5b. What branch?______

5c. What was your MOS/AOC?______

Survey Questions:

6. In your opinion do you feel the group worked effectively in determining groupings for Operations and Maintenance?

   YES NO

If NO, why not?

____

____

____

____

7. In your opinion do you feel other organizational structures within the Army (i.e. personnel proponent) would agree with the groupings the panel has specified for Operations and Maintenance?

   YES NO

Why, or Why not?

____

____

____

____

8. What attribute or attributes would you say had no bearing on the creation of the groupings for **Operations**, and therefore should be eliminated?

____

____

____

____

9. What attributes would you say had no bearing on the creation of the groupings for **Maintenance**, and therefore should be eliminated?

____

____

____

10. Please specify any additional attributes that should have been considered.

____

____

____

____

11. Refer to the Attribute Definitions in the Instruction Packet and rank order the attributes according to the degree of importance for **Operations.**

1. ____________	8. ____________
2. ____________	9. ____________
3. ____________	10. ____________
4. ____________	11. ____________
5. ____________	12. ____________
6. ____________	13. ____________
7. ____________	14. ____________

12. Refer to the Attribute Definitions in the Instruction Packet and rank order the attributes according to the degree of importance for **Maintenance.**

1. ____________	8. ____________
2. ____________	9. ____________
3. ____________	10. ____________
4. ____________	11. ____________
5. ____________	12. ____________
6. ____________	13. ____________
7. ____________	14. ____________

13. Do you feel that the panel would generally agree with your rankings for **Operations** in response to question eleven?

YES NO

If NO, why not

____

____

____

____

14. Do you feel that the panel would generally agree with your rankings for **Maintenance** in response to question twelve?

YES NO

If NO, why not?

____

____

____

____

Additional Comments:

____

____

____

____

PART D1: MOS ASSIGNMENT - OPERATOR

DOMAIN COVER SHEET

DOMAIN ____

MOS Assignment:

____

Rationale for MOS Assignment:

____

____

____

____

____

____

Additional Comments:

____

____

____

____

PART D2: MOS ASSIGNMENT - MAINTAINER

DOMAIN COVER SHEET

DOMAIN ____

MOS Assignment:

____

Rationale for MOS Assignment:

____
____
____
____
____
____

Additional Comments:

____
____
____
____

MILITARY OCCUPATIONAL SPECIALTY (MOS) RESTRUCTURING RESEARCH AND DEVELOPMENT BLUEPRINT

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The views, opinions, and findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation.

MILITARY OCCUPATIONAL SPECIALTY (MOS) RESTRUCTURING RESEARCH AND DEVELOPMENT BLUEPRINT

EXECUTIVE SUMMARY

Research Requirements:

In 1988, the U.S. Army Research Institute (ARI) initiated a focused examination of MOS aggregation issues existing within the Army. The ultimate objective of this effort is to develop and evaluate methods to facilitate the analysis and design of Military Occupational Specialties (MOSs) and Career Management Fields (CMFs) across the Army.

The purpose of the present document is to provide an overall framework of the analytical requirements associated with tools and methods for MOS restructuring. As such, this paper represents the initial effort in the construction of a comprehensive MOS Restructuring Research and Development Blueprint. A completed blueprint would also address data resource requirements, operational and technical feasibility, costs, benefits, design concepts, and research priorities or strategies for both tools and data bases. Full development of the blueprint was beyond the scope of the present effort. The present effort is limited to a thorough examination of MOS restructuring analytical requirements.

Procedure:

Following initial development of a generic MOS restructuring process and a determination of the agencies responsible for its execution, a systems analysis of the restructuring process was conducted. Using the Information Definition, Mod 0 (IDEFo) systems engineering technique, required analytical methods were identified. These required analytical methods provided a framework for the examination of existing analytical methods. 58 existing methods were reviewed. 18 existing methods found to be consistent with restructuring requirements were documented and further analyzed.

The results of these analyses produced two types of research requirements: requirements for tools that have potential existing baselines and new tools that require a full research and development effort.

Findings:

This paper identifies requirements for 16 analytical tools within the process of MOS restructuring. Two of these tools appear to be fully addressed by existing analytical methods.

These include:

- Position Data Analysis Tool; and
- Physical Demands Analysis Tool.

The remaining 14 analytical tools are divided into two groups: Tools that were partially addressed by existing methods and thus could utilize existing methods as a foundation for development and new tools that require "full scale" research and development efforts. Individual elements of one tool, the Task-based Evaluation Tool, fell within both groups. Those analytical tools that could conceivably be developed using an existing methodological baseline include:

- Job Requirements Comparability Tool;
- Personnel Characteristics Tool;
- Task-based Evaluation Tool: Training Concept;
- Manpower Estimation Tool;
- Personnel Requirements Determination Tool;
- High Driver Trade-off Analysis Tool;
- CMF Impact Tool;
- MOS-Training Impacts Tool; and
- Pre-Standards of Grade Authorization (SGA) Trade-off Tool.

Required analytical methods not having an existing tool to serve as a potential baseline include:

- Task-based Evaluation Tool: Military Occupational Classification Structure (MOCS) Identifier Duties and Tasks;
- Task-based Evaluation Tool: Occupational Concept;
- CMF Impact Trade-off Tool;
- Personnel Data Analysis Tool;
- Recruiting Evaluation Tool;
- SGA Development Tool; and
- Post-SGA Trade-off Tool.

In addition to these findings, this paper documents specific tasks required to complete the development of the <u>MOS Restructuring Research and Development Blueprint</u>. Critical to this development is the further development of additional MOS restructuring sub-architectures.

Utilization of Findings:

The identification of analytical requirements associated with tools and methods for MOS restructuring lays a foundation for ARI to determine future research objectives. Additionally, the work reported here provides a framework to complete and maintain the blueprint. The MOS restructuring functional architecture depicted in this paper is a foundation upon which additional restructuring sub-architectures can be developed.

MILITARY OCCUPATIONAL SPECIALTY (MOS) RESTRUCTURING RESEARCH AND DEVELOPMENT BLUEPRINT

CONTENTS

Page

List of Tables

Page

List of Figures

MILITARY OCCUPATIONAL SPECIALTY (MOS) RESTRUCTURING RESEARCH AND DEVELOPMENT BLUEPRINT

Introduction

The Army is continually faced with critical decisions regarding the restructuring of an MOS in order to maintain a strategically balanced alignment of manpower and personnel requirements. These decisions are most often made in support of changes, or combinations of changes in doctrine, training, organizations, and equipment as technology is continuously updated. MOS restructuring is defined as the reassignment of tasks to be performed by an MOS within a CMF and the assignment of new tasks to an existing or new MOS or Additional Skill Identifier (ASI).

As documented in previous research notes (Akman & Haught, 1990; Haught & Akman, 1990a), there exists a critical need for improved tools and methods in all facets of the restructuring process. The convergence of declining demographic trends, recruiting performance, and the growing sophistication of weapons have all contributed to the growing interest in improved methods of MOS design and analysis. MOS restructuring is an integral part of the Army's Life Cycle Model (FM 100-11, 1988). In all functional areas, proponent agencies strive to keep the force structure healthy in order to support emerging mission and force modernization requirements. Indeed, the need for an MOS restructuring action can be triggered within the task environment of any Army life cycle function.

The foundation of this research note is based largely on a continuing indepth research effort into current issues of Army MOS restructuring practices. Much of this research has been conducted over the past year (see Akman & Haught, 1990; Haught & Akman, 1990a). The purpose of this document is to expand on these research efforts and provide an overall blueprint for future research and development efforts in the area of MOS restructuring.

Specifically, six restructuring topics are addressed. First, the generic MOS restructuring process is presented and discussed. The discussion focuses on the Army's concentration on force integration and the link between MOS restructuring and the Army's Life Cycle Model.

Second, the agencies responsible for the execution of MOS restructuring are identified. The focus of this section is on the roles at the school house level. These include the combat developer, training developer, and personnel proponent.

Third, requirements for MOS restructuring analytical methods are presented. This discussion describes a systems analysis of the restructuring process, the identification of analytical requirements, and the identification of required analytical methods.

Fourth, the relevance of existing analytical methods are discussed as they relate to the process of MOS restructuring. Each existing method is described within the context of the analytical requirements essential for successful MOS restructuring.

Fifth, research requirements for developing MOS restructuring analytical methods are presented. These requirements address tools that have potential existing baselines, and new tools that require a full research and development effort.

Finally, tasks required for the completion of the MOS Restructuring Research and Development Blueprint are presented. These tasks represent future research objectives that should be considered by ARI.

MOS Restructuring Process

This section provides an overview of the MOS restructuring process. MOS restructuring is one of many personnel activities necessary for the Army to maintain combat readiness. The restructuring process is presented here within the context of Army systems theory. This is an appropriate context given that the Army's continuing focus on force integration has transformed systems theory into operational reality.

The Army's Life Cycle Model, illustrated in Figure 1, provides an useful depiction of the constant building and rebuilding process of the Army. The goal of the Life Cycle Model is to maintain combat readiness as a total system. The process at work in this model that ensures success is the effective management of change or force integration. If combat readiness is to be maintained as a constant through force integration, then significant change must be confronted and absorbed by those subsystems of the Army that support, organize, train, and equip the force.

A principal component of force integration, and therefore a principal component of the Army's Life Cycle Model, is the effective exchange of information between life cycle functions. This is the vehicle through which change is managed. This concept of information exchange recognizes that life cycle functions do not occur in isolation, hence, the "web" of feedback loops between functions.

In its most basic context, this is the external environment in which the MOS restructuring process must operate. Each life cycle function reflects a unique "task environment" where the steps of the MOS restructuring process will be executed depending on how the restructuring action was initiated.

The MOS restructuring process described in this section is a generic process that fits into the task specific operating environment of any functional area. The determination of specific milestones may vary but the process, analytical tools, and required data remain the same.

As an activity that supports force integration, the MOS restructuring process must be able to confront and absorb the impact of change in any life cycle functional area regardless of the source of change. Hence, in the remainder of this document the word "change" refers to any change or combination of changes in doctrine, training, organizations, and equipment or technology that have the potential to trigger a MOS restructuring action.

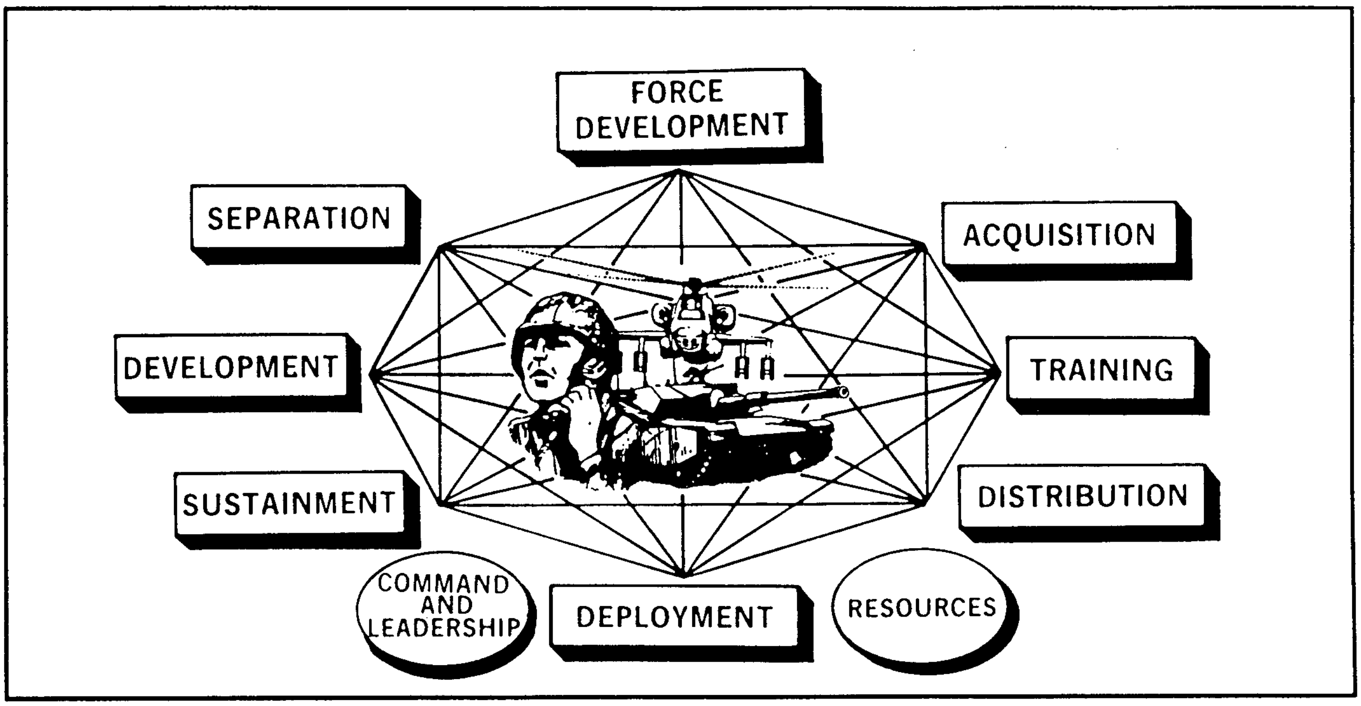


Figure 1. The Army's life cycle model (FM 100-11, 1988).

This is the framework in which the generic MOS restructuring process is presented. Three linked restructuring processes shall be described. First, the MOS Restructure Assessment is presented followed by Requirements-based Restructuring Analysis. These two processes represent required analyses early in the development of notional considerations associated with 100 percent go-to-war requirements. These requirements are not initially constrained by budget considerations. Operations-based Restructuring Analysis is next described and reflects real constraints of budget and manpower.

MOS Restructure Assessment

The purpose of this step is to make an initial determination as to the potential for a future MOS restructuring action due to the introduction of some change. The analyst must resolve the selection of MOSs to operate, maintain, and otherwise support the change. The primary objective is to identify and evaluate the characteristics of the alternative concepts of the change that drive MOS manpower, personnel, and training (MPT) requirements and costs, or may lead to human performance problems. A comparative examination is made between the proposed requirements of the change and the capabilities, resources, and limitations of the existing MOSs. Often the issue is resolved by the selection of an existing MOS and the development of some additional training. When this action is not sufficient, requirements for a new MOS or a restructured MOS arise. Then, an MOS restructuring analysis must be performed to determine how to modify existing MOSs or create new ones to meet the requirement of the change.

An initial MOS restructuring assessment is accomplished by reviewing all available doctrinal, MOS structural (pay grades, task composition, and authorizations) and personnel data to determine the general manpower and force structure implications of the change. Once these are determined, a decision is made regarding the potential need for a MOS restructuring action, and thus a full restructuring assessment. As a rule, MOS restructuring analysis is usually required if any of the following conditions exist:

1. Unique task requirements are created for which no existing MOS can be identified;

2. The tasks associated with the change cannot be supported without restructuring the tasks of an existing MOS;

3. Assigning the tasks to an existing MOS would be against current policy.

4. The new task demands cannot be met without revising the skill level demands of an existing MOS;

5. The task demands of the change will increase or decrease the manpower requirements of an existing MOS to the point where the MOS's current grade structure will no longer be valid.

If the conclusion is that there may be a need for a new or revised MOS to support these new or changed demands, the subsequent requirements-based steps are initiated as part of the MOS restructuring process.

Requirements-based MOS Restructuring

Requirements-based MOS restructuring is initiated if it is likely that existing MOSs cannot satisfy the unique requirements of a change in doctrine, training, organizations, and equipment or technology. Alternatives must be evaluated regarding the revision of existing MOSs or the creation of new MOSs to meet the demands of the change. The requirements-based restructuring process provides the vehicle for this analytical evaluation.

Currently, the Army does not have a formally documented process for executing requirements-based MOS restructuring. Nevertheless, requirements-based restructuring decisions are made as part of Army policy. Although these decisions are loosely guided by limited documentation or time honored "rules of thumb", these decisions are generally logical and systematic and require specific data inputs and analytical tools. The purpose of this section is to document this process as a baseline for improvement and to insure that restructuring decisions are valid and reliable. Figure 2 illustrates the requirements-based MOS restructuring process. Following is a description of each major step, its purpose, and scope.

Task-based Analysis. This step focuses on the development of occupational requirements based on projected task demands. These data allow alternative MOS restructuring concepts or strategies to be evaluated. The step is composed of two analysis functions: Change-Notional Job Requirements Review and Task Aggregation.

Change-Notional Job Requirements Review. The purpose of the review is to assess mission and operational concepts as a basis for enumerating task requirements in terms of activities, frequencies, and other job characteristics that may be affected. This process focuses on the development of occupational requirements based solely on projected demands. Often task data from similar changes are used to develop notional task lists for comparison with the existing soldier MOSs. These data allow an initial determination of the feasibility of alternative MOS restructuring concepts or strategies for the proposed change. These data are used to create a foundation for MOS restructuring requirements and decisions.

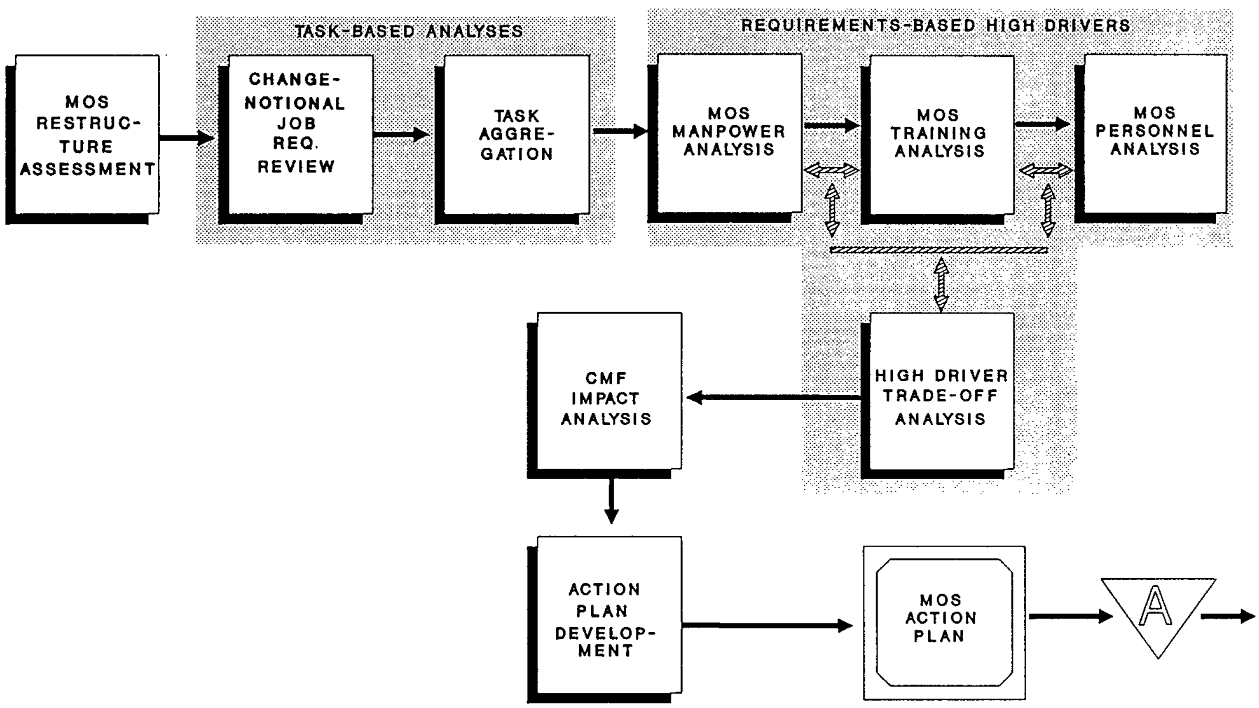


Figure 2. The requirements-based MOS restructuring process.

Task Aggregation. This step reflects the logical extension of the Change-Notional Job Requirements Review. A comparative analysis is conducted between existing target MOS task lists and task lists associated with the change. This analysis is performed to ascertain the MOSs most capable of performing the tasks required by the change. The MOSs (if any) that provide the greatest capability to support the new task lists are selected for further development.

Next, a task deficits list is developed to identify tasks that can be incorporated into each selected MOS's task list with minimal remodeling of the MOS's existing task structure. This process is aimed at further defining the target MOS's capability to support the change and minimizing the impact on MOS training and force structure.

Finally, the task requirements of the change that cannot be supported by the current MOSs are combined with the existing target MOS's tasks. The combined tasks are then analyzed and structured to most efficiently meet the demands of the change. This structuring process provides an indication of the optimal task composition and skill level organization to meet the requirements of the change. If the existing MOSs cannot be identified to support the change, then the new task requirements are aggregated into notional task lists and skill levels. This becomes the basis for the development of new MOSs.

The output from the task aggregation process provides either revised task lists for current MOSs or lists of tasks for notional MOSs that must be developed. These task lists constitute the baseline for the restructure of the existing MOSs or the development of new MOSs.

High Driver Analysis. There is little value in developing or considering costly changes to doctrine, training, organizations, equipment, or technology, if an acceptable number of soldiers, with the required skills and aptitudes, cannot be trained to support the changes properly. Thus, considerable emphasis is placed on effectively addressing MPT issues early in the process of considering a potential change. Successful MPT decisions (manpower costs, personnel aptitudes and skills, and training programs and resources) are imperative to the success of force integration. The three steps described below represent the "high drivers" of the requirements-based MOS restructuring process.

MOS Manpower Analysis. The purpose of this step is to estimate the total number of MOS positions needed to support the change. This step should not be confused with the development of formal manpower requirements criteria (MARC) for inclusion in Army Regulation (AR) 570-2. This analysis process is performed judgmentally based on knowledge of the manpower requirements of similar systems and anticipated reliability, availability, and

maintainability (RAM) characteristics of the new system. Judgements are made of the time required, skill level needed, and grade structure required of personnel to perform each task on the MOS task lists developed through Task Aggregation.

Once the analysis is completed, estimates of MOS productive time, grade and skill levels, and total number of MOS positions can be developed to determine the overall manpower support required by the change. After the requirements are determined, current manpower constraints are evaluated in terms of the projected requirements and unresolved manpower resource issues are documented.

MOS Training Analysis. The purpose of MOS Training Analysis is to determine the training resource requirements generated by the change and subsequent MOS task restructuring. As part of the requirements-based MOS restructuring process, this analysis is performed to acquire an overview of training resource requirements to serve as a basis for generating an initial training plan. The process provides for the analysis of tasks associated with the change, existing MOS tasks, manpower requirements, as well as doctrinal and organizational requirements to determine the critical tasks to be performed by the MOS after the change occurs.

Once the critical tasks are established an initial plan for training these tasks is developed. The initial training plan includes estimates of the length of training, number of instructors required, number of classes per year, number of students per year, and projected increases or decreases in the trainees, transients, holdees, and students (TTHS) account. This should be done within the context of the Army Training and Doctrine Command (TRADOC) Pamphlet (PAM) 350-4, and other training policies that forecast Army training strategies. Existing training constraints are then evaluated in terms of the projected training requirements and unresolved training resource issues are documented.

MOS Personnel Analysis. Through this step the analyst determines if the MOS manpower and training decisions made regarding the change are supportable by the current Army personnel and force alignment process. The MOS manpower and training requirements are analyzed to assess their implications on various personnel resource requirements. Among the information to be developed during this process are (1) estimates of accession requirements, (2) definition of career paths, (3) development of training paths, (advanced individual training, primary leadership training, basic noncommissioned officers training etc.), (4) determination of grade distribution and advancement probabilities, (5) determination of MOS retention requirements, and (6) MOS ability types and levels. Once this information is established, existing personnel constraints are

evaluated in terms of the projected personnel requirements and unresolved personnel resource issues are documented.

High Driver Trade-off Analysis. Throughout requirements-based analyses, trade-offs between change-driven task requirements and MPT requirements must be considered. As the MOS solutions evolve, the tradeoffs between the projected and current MPT resources must repeatedly be examined. Thus, trade-off analyses are performed systematically throughout all the analytical steps.

The location of the trade-off analysis step within the High Driver Analysis process reflects the cumulative effect of all trade-off assessments, rather than a single comprehensive trade-off analysis. The step reflects the concept that solutions proposed throughout the High Driver Analysis process are fully developed and refined prior to proceeding to Career Management Field (CMF) Impact Analysis.

If the MOS restructuring concept is not adequately developed, performing an effective CMF Impact Analysis is not possible. Through the High Driver Trade-off Analysis process an MOS Notional Plan is created that documents MOS solutions and drives successful CMF Impact Analysis.

CMF Impact Analysis. The purpose of the CMF Impact Analysis is to perform "macro" level assessments evaluating the effect of integrating a new or modified MOS structure into the Army. During CMF Impact Analysis, estimated MOS MPT resources are evaluated against current CMF and Army MPT resources. The main thrust of the analysis is to answer these questions within the scenario of current or projected Army constraints:

1. Will the manpower requirements needed to support the change have negative impacts on the capability to provide the resources needed for existing MOS, CMF, or Army manpower requirements?

2. Will the training requirements needed to support the change have negative impacts on the capability to provide the resources for existing MOS, CMF, or Army training requirements?

3. Will the personnel requirements needed to support the change have negative impacts on the capability to provide the resources for existing MOS, CMF, or Army personnel requirements?

Throughout the analysis process, systematic trade-offs are made addressing relevant CMF issues. The MOS Notional Plan along with the various outputs from the CMF Impact Analysis provide constraints and inputs to the trade-off process. This process

produces macro MPT solutions that ensure that new MOS problems are not created through focusing exclusively on the specific MOS issues of the change. These solutions are documented as a Preliminary MOS Design.

Action Plan Development. The final step in the requirements-based MOS restructuring process is to document all findings and forward the results to the agency responsible for initiating or administering the consideration of the proposed change. The MOS Notional Plan and the Preliminary MOS Design are used to develop an MOS Action Plan for this purpose.

The MOS restructuring strategies and requirements will document the conceptual MOS design for the proposed change. When the Army prepares to initiate the change, these results will serve as guidance to the personnel proponent responsible for initiating operations-based MOS restructuring analysis and preparing the MOS action for Department of the Army (DA) approval.

This section has identified the principal steps in requirements-based MOS restructuring analysis. This systematic portrayal is often altered due to limited time and resources and often optimal performance of this analysis process is interfered with. Nonetheless, these analyses must be performed to create the solid foundation of MOS restructuring requirements needed to effectively evaluate and consider the impact of the proposed change. This concludes the requirements-based MOS restructuring process. The focus now shifts to developing support for those MOS restructuring requirements developed during the requirements-based process. The process supporting this new focus is known as operations-based MOS restructuring.

Operations-based MOS Restructuring

Operations-based MOS restructuring deals specifically with creating a personnel support system to meet the restructuring requirements of the change. Operations-based analyses are performed utilizing existing resources. The goal of these analyses is to provide a structure for the Army to access, train, distribute, develop, and sustain the personnel force in accordance with the new restructuring requirements. Operations-based MOS restructuring is an ongoing process in the U.S. Army and the Army's personnel proponents are well-versed in performing the required analyses.

AR 611-1, Military Occupational Classification Structure (MOCS) and Implementation, serves as the major source of policy governing the establishment and maintenance of MOSs and CMFs. The document defines the methods to be used in developing, maintaining, and changing the MOCS and thus drives much of operations-based restructuring. Procedural guidelines for the

execution of operations-based MOS restructuring analysis are documented in the Army's Guide for Preparation of Changes to the MOCS (MOCS Handbook) for use by the personnel proponents.

Although these guidelines are limited and are not alone adequate to meet all requirements of MOS restructuring, the guidelines do serve as a strawman for operations-based MOS restructuring analysis. This section documents the operations-based MOS restructuring process as a baseline for improvement and to insure that restructuring decisions are valid and reliable. Figure 3 illustrates the operations-based MOS restructuring process. Following is a description of each step, its purpose, and scope.

Pre-Standards of Grade Authorization (SGA) Analysis. Pre-SGA Analysis activities are conducted to develop data that feed and drive the development of a personnel support system meeting the restructuring requirements of the change. Each of the Pre-SGA Analysis activities are outlined below.

Position Data Analysis. This step involves a detailed analysis of the authorized positions affected by the change. Position Data Analysis is accomplished by conducting a detailed review of Army authorization documents and data generated through the requirements-based MOS restructuring process. From these data, each position required is identified in great detail. A composite picture of an MOS is drawn and is expressed in the total number of authorizations by MOS and skill level, as well as by grade cell and aggregate. If the functions are to be transferred from one MOS to another, this transfer is reflected in this analysis.

The results of this analysis provide the proponent with a broad overview of the relative health of the MOSs, types and numbers of organizations in which the MOSs are found, the geographic locations and organizations (Battalion, Brigade, Division, etc.) where the MOSs are authorized, total authorized positions of the MOSs, grade structure needs, and combat probability of the MOSs.

Personnel Data Analysis. In addition to the analysis of positions affected by the change, the personnel proponent is also required to perform a Personnel Data Analysis. This analysis is essential in assessing the impact on personnel supportability. The general areas of concern are:

a. How and from where personnel will be accessed.

b. The MOS career path in which the soldier can expect to progress.

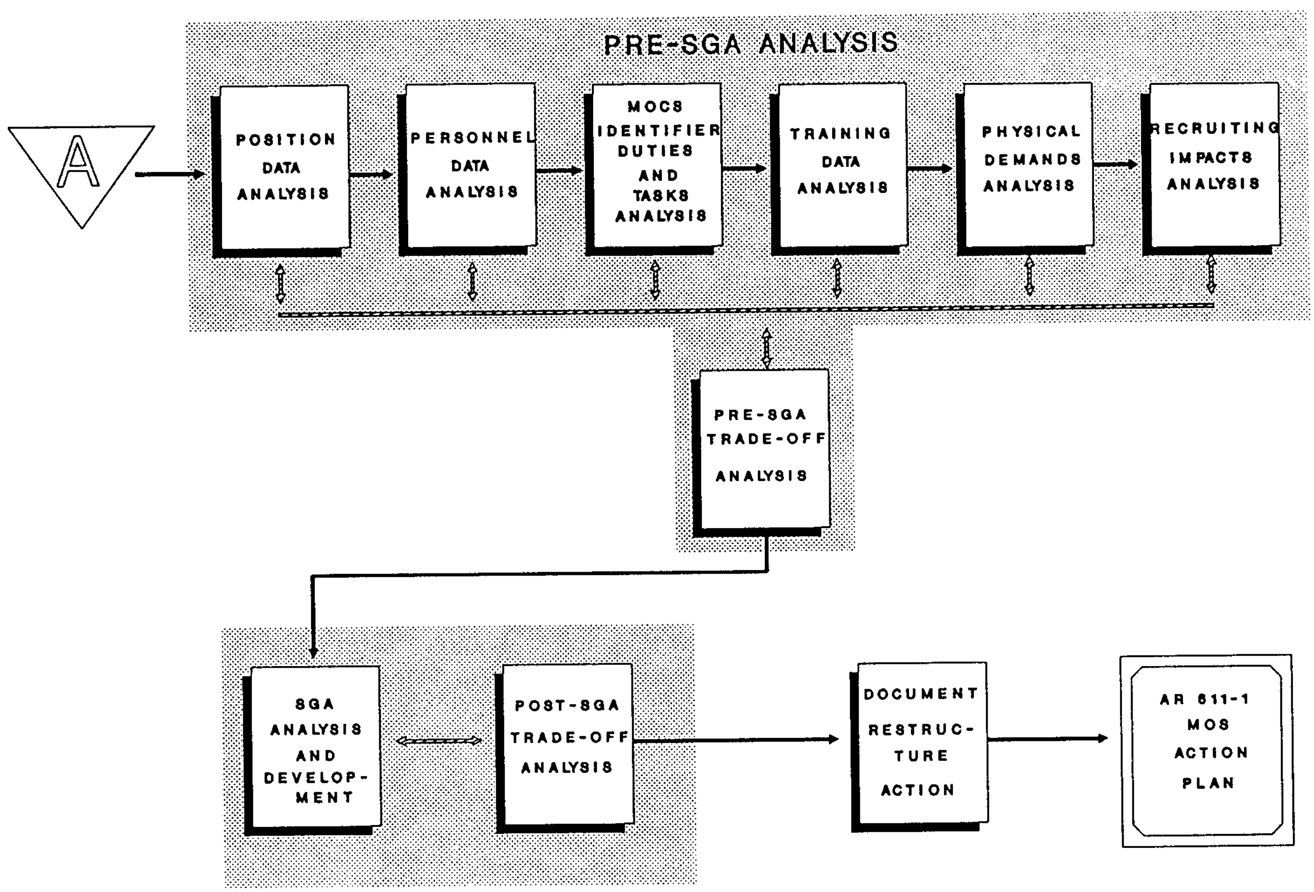


Figure 3. The operations-based MOS restructuring process.

c. Space Imbalanced MOS (SIMOS) implications (a SIMOS is one where more than 55 percent of the MOS authorizations are based outside the continental U.S.).

d. Utilization of female personnel and what impact will result from a revision.

MOCS Identifier Duties and Tasks Analysis. The proponent performs this analysis to determine what modifications, if any, must be made in the description of the MOS's duties and tasks. In the case of an MOS restructure action, this analysis involves a review of AR 611-201, Program of Instruction (POI), Army Occupational Survey, and inputs from Position Data Analysis. From this review, new or revised MOCS identifier duties and tasks are developed.

In the case of a new MOS, the descriptive duties and tasks must be developed. Army policy requires that skill level 1 tasks be included unless precluded by the complexity of the tasks. If it is determined that the MOS will start beyond skill level 1, a detailed justification must be submitted with the MOS action.

Occupational surveys are used during this analysis to the maximum extent possible. When no survey exists, the proponent may use various other methods such as the use of subject matter experts, results from job and task analysis, or convene a joint working group of doctrine and training developers, subject matter experts, and MOS analysts to develop this product.

Training Analysis. The personnel proponent must develop a strategy for training new or revised occupational identifiers. This step in MOS restructuring analysis is usually shared with the training developer and the teaching branch in which the proposed training is or projected to be taught. Areas considered in this analysis are:

a. Length of current or projected training.

b. Number of classes per year.

c. Number of students per class.

d. Number of students per year.

e. Training man years.

f. Increases or decreases in the TTHS account or instructor requirements.

g. Training start date.

Physical Demands Analysis. A detailed analysis is performed on the physical work requirements for every entry level task to be performed by the MOS. Based upon the most physically demanding task performed, the proponent classifies the MOS as light, medium, moderately heavy, heavy, or very heavy. For every task to be analyzed, a Physical Demands Analysis worksheet is completed to insure all areas are addressed. Four steps are required for completing a physical demands analysis.

a. The proponent assembles all literature pertaining to the MOS under study (Field Manuals, Technical Manuals, Programs of Instruction, etc.). If working on a new MOS, the proponent may use the resultant tasks from job task analysis.

b. Explicit and implicit tasks are identified.

c. Where possible, soldiers are observed performing the procedures, processes, skills, tasks, and work objectives of the MOS. Other data are collected by interviewing supervisors and subject matter experts.

d. The data are then reviewed, analyzed and a physical demands rating assigned.

Recruiting Analysis. Impact on the Joint Optical Information Network (JOIN) must be determined. Any alteration in MOS title, skill level 1 tasks, physical demands, or accession strategy must be identified. If the MOS qualifications or training are to be revised, the U.S. Army Recruiting Command may have to renegotiate enlistment contracts. For new MOSs, recruiting strategies must be developed and documented.

Pre-SGA Trade-off Analysis. Pre-SGA Trade-off Analysis represents systematic evaluation of trade-offs between personnel data, position data, training, physical demands, and recruiting analysis. These trade-offs are made throughout Pre-SGA Analysis and ensure that a balanced, realistic, affordable approach to the development of MOSs is created prior to SGA Analysis and Development.

SGA Analysis and Development. SGA Analysis and Development is performed in an effort to meet mission requirements and optimize the career pattern of an MOS. This analysis may begin during any phase of the operations-based MOS restructure analysis but usually begins during Position Data Analysis and is conducted in parallel with Pre-SGA Analysis. Data from the preceding steps are used to "feed" the SGA analysis process. SGA analysis is perhaps the most difficult analysis performed during an MOS restructure effort. It is highly constrained by Congressional,

Department of Defense, Army, and, to some extent, local policies. There are six areas of concentration for this phase of analysis:

a. Duty position titles are developed to be descriptive of the position they annotate.

b. Decisions are made as to the skill level at which the MOS will start and if any ASIs or Specialty Qualification Identifiers (SQIs) will be associated with the MOS.

c. Each authorized position is reviewed and assigned an appropriate rank (E3, E4, E5 etc.) reflective of the skills or supervision requirements of the position.

d. A notional grade pattern is developed using the Average Grade Distribution Matrix, which is a grade percentage model developed by the Army and designed to help in assessing career progression and optimizing the structure of the MOS.

e. The basic grade pattern is adjusted to incorporate constraining factors such as grade ceiling constraints, mission requirements, training requirements, special skill needs, and career progression concerns.

f. The SGA analysis is repeated until the notional grade pattern represents the proper ("best") solution when evaluated against Army authorizations documents.

Post-SGA Trade-off Analysis. Post-SGA Trade-off Analysis represents the systematic method of ensuring a balance between supervisory positions, subordinate positions, grade structuring, and career path. Trade-offs are made throughout the SGA development process. The results from trade-off analysis represent SGA data inputs to the development of documentation for the proposed AR 611-1 MOS Action.

Documentation of the Restructure Action. After all phases of MOS analysis are completed, the personnel proponent analyzes the products of the analysis for implications that impact on personnel supportability. This information may include the need for transition training, MOS reclassification, MOS conversions, general assignment or utilization needs, utilization of transition ASIs, and other information vital to a smooth change in personnel policy.

Following this analysis, the personnel proponent prepares a report that outlines why a revised or new MOS is needed and the methodology for the initiation of the proposed AR 611-1 MOS

action. This report documents a plan for proposed changes to an existing MOS or the addition of a new MOS into the force structure.

Responsible Agencies

This section identifies and describes the principal agencies having analytical and decision responsibilities with regard to the MOS restructuring process. The agencies described play a critical role in any MOS restructuring action triggered within an Army functional area. These agencies work in a largely cooperative fashion throughout the restructuring process to ensure effective force integration. The primary focus of this discussion is aimed at the school house level for both requirements and operations-based MOS restructuring efforts. Those agencies beyond this level are addressed in less detail.

Requirements-based Restructuring

As previously mentioned, the Army does not have a formally documented mechanism for the execution of the requirements-based MOS restructuring process. Currently, requirements-based restructuring is largely an informal process initiated and administered by the training center's combat developer. Included in this process are, as a minimum, the training developer and the personnel proponent. Each participant brings a unique viewpoint to the evaluation of potential revisions to existing MOSs or the creation of new MOSs to meet the demands of a particular change.

The requirements-based restructuring process requires this collaborative analytical approach to the development of requirements for an MOS restructuring action. A single independent decision in the implementation of a restructuring action by one participant will often affect or compromise the integrity of the other participants' program designed to support the very same action. Therefore, participation of all three disciplines in the requirements-based restructuring process is imperative.

The combat developer has lead responsibility in the requirements-based restructuring process. The combat developer is responsible for ensuring all restructuring requirements dictated by the change are identified and documented. To this end, the combat developer in cooperation with the training developer and personnel proponent (1) determines tasks requirements, (2) selects the MOSs to support the change, (3) determines manpower requirements, (4) determines the adequacy of the MOSs to support the requirements, and (5) determines the need for MOS restructuring.

The training developer has responsibility for identifying the impact the restructuring requirements will have on training requirements. In support of the restructuring effort, the

training developer (1) analyzes training requirements and develops training strategies, (2) determines training constraints, (3) develops and analyzes critical training tasks, (4) determines aptitude and skill needs, (5) develops collective and individual training plans for the new or revised MOSs, and (6) provides training issues input to the combat developer to support the restructuring decisions.

The personnel proponent makes recommendations to the combat developer on issues such as (1) personnel constraints, (2) grade structure requirements, (3) personnel accession strategies, (4) distribution of personnel quality, as well other personnel life cycle management issues.

In addition, several Army agencies play a role in requirements-based MOS restructuring beyond the school house level. These would include the TRADOC; the U.S. Army Force Integration Command Agency (USAFICA); the Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS); and the U.S. Army Personnel Integration Command (USAPIC).

These organizations are involved in developing and analyzing concepts from which the doctrinal, training, organizational, and materiel needs of the Army evolve. These agencies therefore have an impact on initiating the changes that ultimately occur in the Army. Hence, these organizations have an interest and investment in the determination of requirements for the integration of these changes.

The roles of these agencies is specified in various documentation including, but not limited to: AR 310-31, Management System for Tables of Organization and Equipment (The TOE System); AR 310-49, The Army's Authorizations and Documents System (TAADS); and TRADOC Regulation 11-15, Concepts-based Requirements System.

Should the proposed change involve the acquisition of new or improved equipment, there are several documents that need to be discussed specific to equipment related changes. These documents further define responsibilities during the requirements-based MOS restructuring process within the context of the Manpower and Personnel Integration (MANPRINT) initiative. Initial MOS requirements for equipment being acquired through the materiel acquisition process are ultimately reflected in the Basis of Issue Plan (BOIP) and the Qualitative and Quantitative Personnel Requirements Information (QQPRI). These documents have specific data requirements and therefore drive the determination of responsibilities during the requirements-based process.

AR 71-2 defines the event sequences, content requirements, and decision review procedures for development of the BOIP and QQPRI documents. Requirements for revised or new MOS and CMF categories are based on input from the BOIP Feeder Document (BOIPFD) that details the equipment and proposed density. Responsibilities for developing the specific personnel requirements are shared in the coordinated decision processes involving the materiel, combat, and training developers.

A QQPRI reflecting initial estimates of the operator numbers, including MOS categories, skill levels, and ASIs for operators and maintainers, is prepared by the materiel developer responsible for research and development in close coordination with the combat developer. Identification of supervisory positions including MOS and ASI is prepared by the combat developer.

Estimates of the required formal or on-the-job training for the MOS proposal is completed by the training developer. For new or revised MOS categories, the developer must provide estimates of the hours of training in each required subject for each MOS at each skill level.

This QQPRI is forwarded, through TRADOC, to USAPIC which reviews and approves the proposed MOS, SQI, and ASI occupational data required to operate and maintain the equipment. Requirements for new or revised MOS structures are reviewed by affected Major Army Commands (MACOM) prior to final approval.

AR 71-2 provides details for the procedures and justifications for new or revised MOS categories. Documentation requirements for new or revised MOSs include the materiel, combat, and training developers and closely follow the procedural requirements utilized during operations-based restructuring. Although AR 71-2 charges the materiel, combat, and training developers with documenting MOS requirements in the QQPRI, the personnel proponent has sole responsibility for ensuring that proposed MOSs are both supportable in terms of personnel life cycle management and well defined in terms of accessions and training.

Once the requirements-based MOS restructuring decisions are made, the personnel proponent assumes responsibility for operations-based restructuring analysis. This includes the development of the required MOS restructuring action submittal for DA approval.

Operations-based Restructuring

Operations-based MOS restructuring deals specifically with utilizing existing resources to create a personnel support system

that provides a structure for the Army to access, train, distribute, develop, and sustain the personnel force needed to meet the restructuring requirements of the change. Operations-based MOS restructuring is an ongoing process in the U.S. Army and the Army's personnel proponents are well-versed in performing the required analyses.

The principal organizational entities responsible for operations-based MOS restructuring activities are outlined in AR 600-3, The Personnel Proponent System, published by the Office of the Deputy Chief of Staff for Personnel (ODCSPER). The primary operational responsibility is delegated to the Chief, Personnel Proponent Office at each Army branch and functional area (usually the training center or school). The personnel proponent is then supported by the combat developer and training developer from the same functional area.

AR 600-3 assigns the personnel proponent office with responsibility for administration and management of all personnel life cycle management functions keyed to assuring the overall supportability of the CMFs and associated MOSs within the branch or functional area. As defined in the regulation, the personnel proponent office is responsible for evaluation and recommendation of personnel management issues in the following areas:

1. Structure in Terms of Grade Level and Population Density
2. Accession
3. Individual Training and Education
4. Distribution
5. Unit Deployment
6. Sustainment
7. Professional Development
8. Separation.

As a result of this regulation, the Army has established approximately 30 personnel proponent offices. Each has lead responsibility for preparing the AR 611-1 MOS action submittals recommending changes to the CMFs and MOSs within their authority.

As previously stated, AR 611-1 serves as the major source of policy governing the establishment and maintenance of MOSs and CMFs. As such, AR 611-1 prescribes the command responsibilities for developing, maintaining, and changing the MOCS. The responsibilities described are therefore applicable to all aspects of the operations-based MOS restructuring processes. The regulation provides the overall policy and directives for management of the subordinate AR 611 series regulations.

Included in AR 611-1 are the sources, content, and staffing requirements for proposed changes and the schedule of

implementation for approved modifications. Key responsibilities that are assigned during the operations-based process are outlined in AR 611-1. These would include management, update, and staffing of proposed changes to the MOCS for the: ODCSPER; Deputy Chief of Staff, Logistics (DCSLOG); Army Materiel Command (AMC); TRADOC; and USAPIC.

Requirements for Analytical Methods

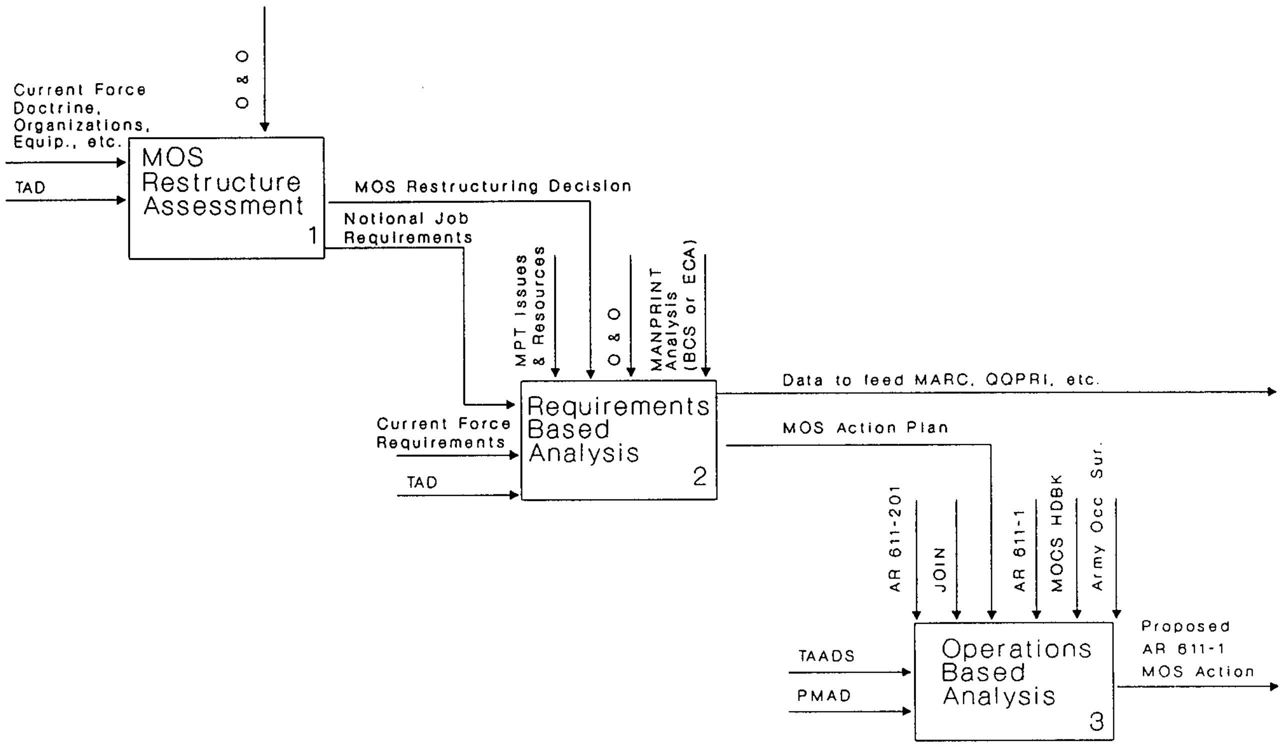
The purpose of this section is to identify requirements for analytical methods and tools in the MOS restructuring process. The research approach chosen to identify these requirements centered around a top-down integrated systems analysis of MOS restructuring. The approach was designed to provide an accurate and complete representation of the analysis requirements of MOS restructuring and provide the information necessary to determine the nature of required analytical methods. This integrated analysis was conducted using the Information Definition, Mod 0 (IDEFo) systems engineering technique (Marca & McGowan, 1987). The IDEFo technique provides a structured format from which to build descriptive models in terms of a hierarchy of functions or activities.

This section first provides a brief introduction to the IDEFo methodology and its use in the construction of a functional baseline for MOS restructuring. Second, the identification of steps that indicate a potential requirement for an analytical tool or method are presented. Finally, the identification of analytical methods required in MOS restructuring are presented and the characteristics of these analytical methods and tools are discussed.

IDEFo Methodology: Building a Functional Architecture

An IDEFo model is composed of boxes that contain functions or activities and lines connecting the boxes that describe data flowing between activities, as illustrated in Figure 4. Input data enter each activity from the left and output data exit the box from the right. Constraints or regulations on the activity are indicated on the top of each box and the bottom of the box indicates the mechanisms that perform the activity. The constraints may also serve as inputs to the activity. Input data are transformed by the activity into the output data using the stated mechanism within the context of the constraints placed on that activity.

The construction of the model begins with the whole system reflected as a single unit, a box with arrow interfaces. The interface arrows of this parent diagram are intentionally general, abstract, and lacking in detail as they represent the complete set of external interfaces to the systems as a whole. This box is then detailed on subsequent diagrams with sub-functions connected by interface arrows. This decomposition of the parent diagram reveals a complete set of sub-modules that may be similarly decomposed to expose even more detail. The name of each sub-module and its labeled interfaces constrain the specific context of each sub-module.



A0 - Restructure MOS

Figure 4. Sample IDEFo diagram.

Each diagram has a principal theme, running from the incoming input arrows to the outgoing output arrows. The main path through the boxes and arrows delineates the main function of the diagram. In reading the diagrams, one should scan the diagram of interest to acquire an overall impression of its main function. The reader should then refer back to the parent diagram and note major inputs connected to the diagram. By identifying the most dominant inputs, constraints, and outputs, the reader can mentally walk through the diagram from left to right using the main function and text as a guide.

An IDEFo model does not represent a flowchart. Flowcharts describe decision paths and specify a sequence of steps that yield a result. The IDEFo model describes the functioning of a system or process utilizing well defined inputs, outputs, and information transformation activities. The model is expressed in terms of the constraints and data requirements that must be satisfied rather than restricting the process to a sequence of events. The model illustrates the relationships that must be true for successful functioning of the system regardless of the particular sequence that is followed.

Initial diagrams of the MOS restructuring process were created through a careful review of existing literature regarding MOS restructuring (see Akman & Haught, 1990; Haught & Akman, 1990a). These diagrams were created by the model developer in draft form for review by an SME. Once an initial review was completed, the development process involved a succession of iterative reviews that required considerable interaction between the SME and the system developer. Revisions were made to the diagrams throughout the development process in an effort to achieve a high level of detail and a thorough representation of the MOS restructuring process.

The model developed for this research effort was generated without consideration of the mechanisms that perform the documented activities. This allowed complete development of the functional steps in MOS restructuring without the introduction of potential biases regarding how the activity is currently or should be accomplished. The architecture was thus developed exclusively in the context of "what is required". Beginning with this orientation ensures that the problems and issues germane to the restructuring process are fully understood before the details of specific research requirements are developed.

The result of this system engineering analysis is the MOS restructuring architecture shown in the detailed IDEFo diagrams included in Appendix A. In a top-down format, these diagrams display a totally integrated MOS restructuring process. The integration contained in the architecture pulls together the many aspects and details of MOS restructuring into one developmental model.

The IDEFo diagrams also provide the basis for the identification of functions in the MOS restructuring process that have analytical requirements. These functions may benefit from the application of existing analytical methods or tools or the development of new tools.

Identification of Functions Having Analytical Requirements

Following the system engineering segment of this research, an investigation of the various steps of the IDEFo architecture was conducted to find prospective functions where analysis is required and a need for analytical methods or tools exists. This section identifies those functional steps that have analytical requirements in the MOS restructuring process. Functions or related sets of functions that are amenable to the introduction of improved analytical tools or methods are identified.

Through a critical examination of the principal theme and dominant inputs, constraints, and outputs of each step, conclusions were made regarding the nature of each step in the hierarchy. Two basic types of functional steps were identified: steps having procedural requirements and steps having requirements for analysis. Those steps identified as having requirements for analysis were documented. These functions are highlighted in Figure 5.

A preliminary analysis of these functions reveals that there is significant potential for the introduction of improved analytical tools and methods within the MOS restructuring process. 43 potential functions were identified: 2 within the domain of restructure assessment; 20 within the domain of requirements-based restructuring, including two points requiring trade-off analysis; and 21 within the domain of operations-based restructuring, including two additional points requiring trade-off analysis.

The recurrence of requirements for trade-off analysis demonstrates the importance of trade-off analysis as a vehicle for maintaining focus when optimizing the MOS restructuring action. In the requirements-based setting, trade-offs are made between strategic MPT requirements leading to choices regarding MOS selection and methods of supporting these selections. A high degree of refinement is required if the resulting data inputs to operations-based restructuring are to be valuable. As indicated in the systems architecture, this refinement is accomplished through trade-off analysis. In the operations-based setting, the ground rules dictate a zero sum gain process; all changes must be balanced against other key decision variables. These trade-offs must be made in a systematic manner if the restructuring action is to be successful.

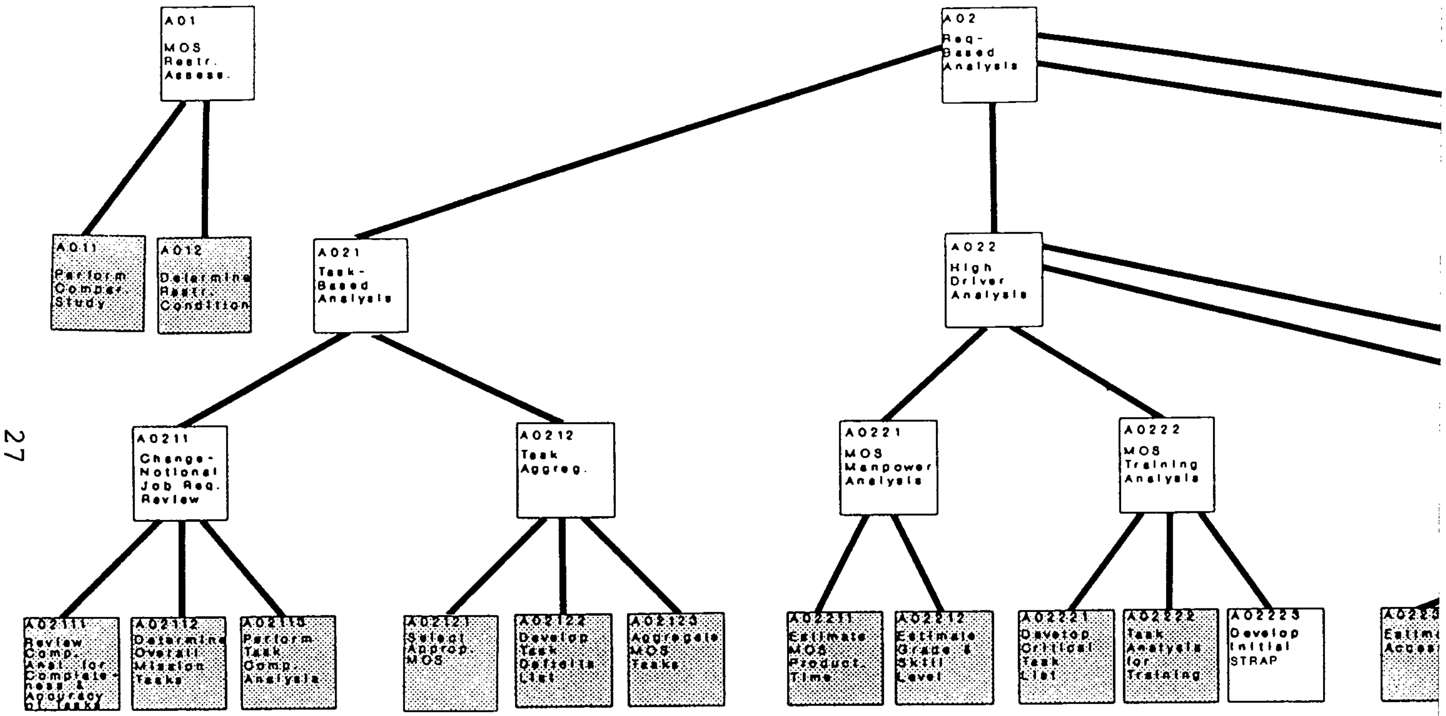


Figure 5. MOS restructuring steps having requirements for analysis.

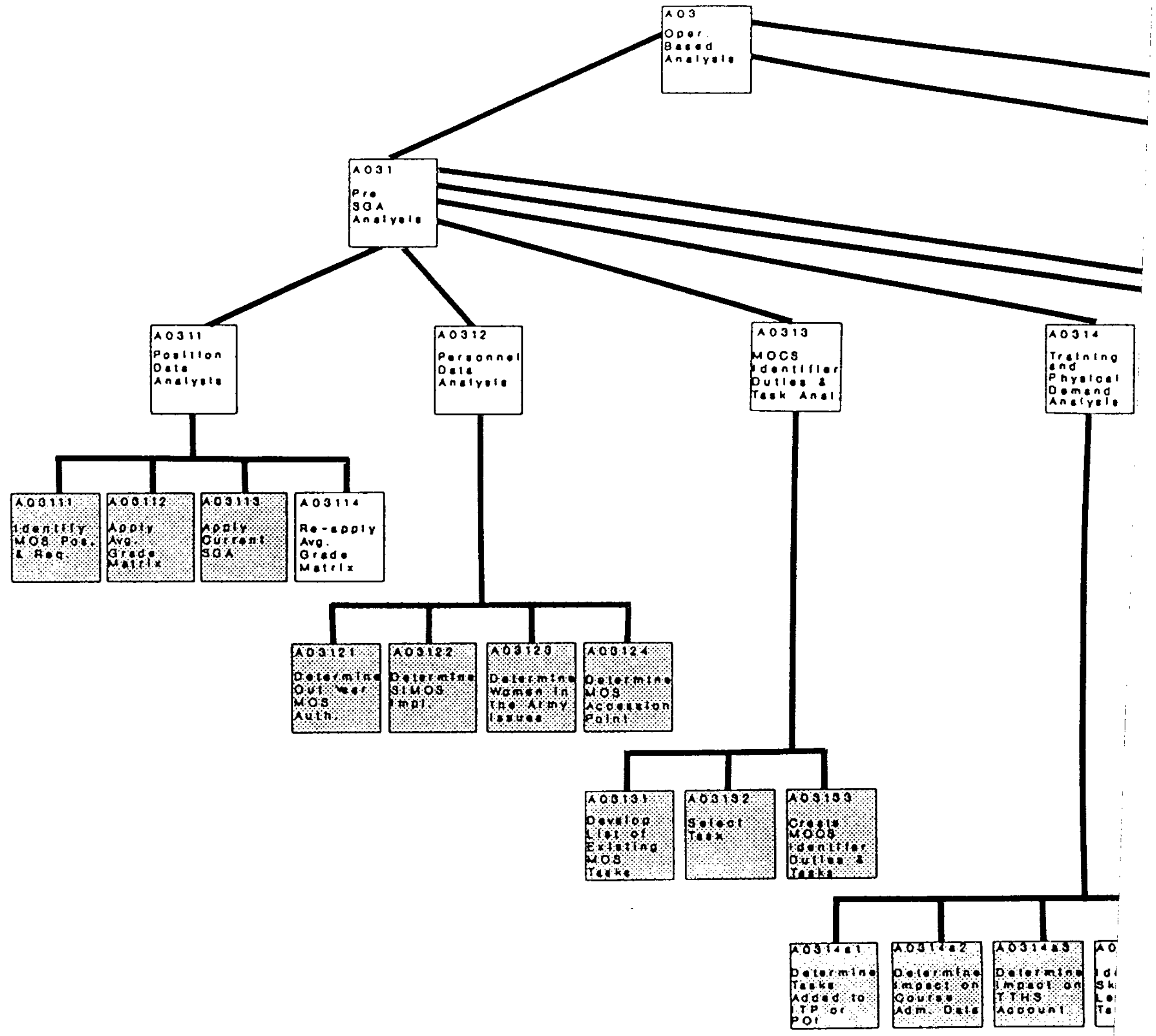


Figure 5. MOS restructuring steps having requirements for analysis (

In order to respond to the needs of each functional step having analytical requirements, the requirements for analytical methods that satisfy the criteria of each function were determined. This provides a clear understanding of the desired characteristics of analytical tools for MOS restructuring.

Identification of Analytical Methods

Working from the baseline of functions selected as having analytical requirements, a detailed evaluation was conducted to determine the characteristics of the methods, or tools, required for each function or related set of functions. 16 types of analytical methods were identified for MOS restructuring. These analytical methods, shown in Figure 6, respond to the functional requirements of the analytical steps identified in the MOS restructuring system architecture.

Following are brief descriptions of the basic characteristics of each analytical method required. The required analytical methods are presented in terms of the MOS taxonomy developed by Muckler, Seven, & Akman (1990). The taxonomy is designed for use in the evaluation of changes in soldier tasks and MOSs and as such is germane to the present discussion.

The taxonomy establishes the dimensions for evaluation by defining the dimensions that should be measured and assessed when MOS changes occur. The taxonomy consists of three levels. The first level is the job level (task level) which includes appropriate soldier characteristics and critical task variables. The second level is the MOS description, and the third is characteristics of the CMF (see Muckler et al. for a complete discussion).

Table 1 provides information that augments the description of each analytical method. Thus each of the analytical tools is described in terms of the level of evaluation it addresses and the ten basic characteristics defined in Table 2.

Job Requirements Comparability Tool. This tool is required early in the restructuring process during MOS Restructure Assessment and makes evaluations at the job level. This comparability tool would allow the analyst to explore alternative job designs and compare them with the job requirements of existing MOSs. Results from this analysis allow initial decisions to be made regarding the need for restructuring or creating a new MOS. Initial job requirements are also identified. These data will trigger the requirements-based process if an MOS action is needed.

Task-based Evaluation Tool(s). A Task-based Evaluation Tool is required at several points in the MOS restructuring process to make job level assessments. The requirements for each use would

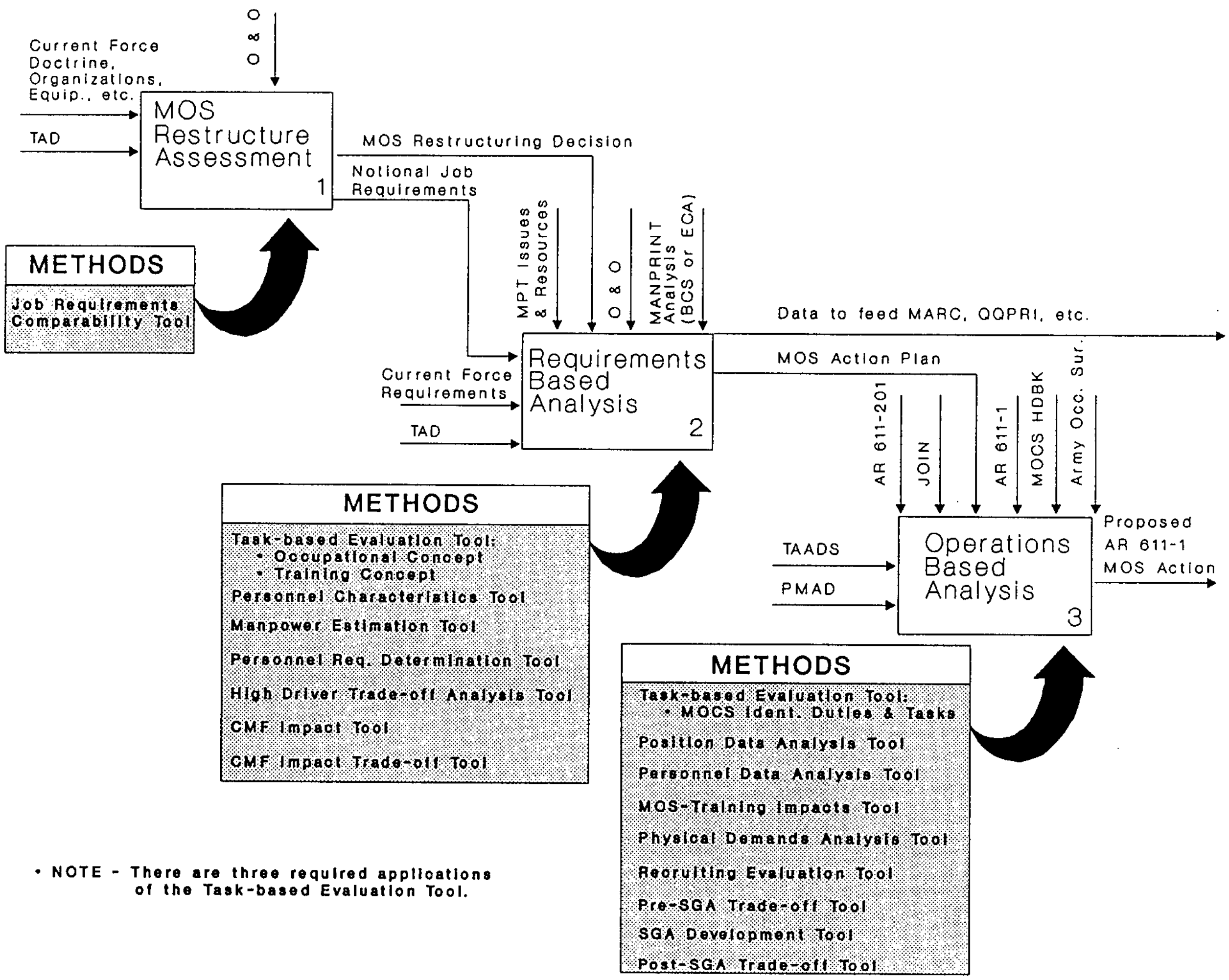


Figure 6. MOS restructuring required analytical methods.

Table 1

Data that Enhance the Description of Each Required Analytical Method

Method	Functional Step(s)	Typical User Educational Background	Typical Grade Level	Principal Agency	Precision of Results	Required Analytical Technique(s)	Data Input Types	Typical Response Capability
Job Req. Comp. Tool	A011, A012	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Combat Developer	Conceptual Determination	Compar. Based Task-Based	Subjective Data Data Bases Budgeting Data Task Data	4 - 6 weeks
Tasks-Based Eval. Tool	A02111, A02112, A02113, A02121, A02122, A02123	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Combat Developer	Conceptual Determination	Compar. Based Task-Based	Task & Job Req.	6 to 8 weeks
	A02221, A02222	12 to M.S.	GS 9-12 Civ. E7-03 Mil.	Training Developer	Conceptual Determination	Compar. Based Task-Based	Task & Job Req.	4 to 6 weeks
	A03131, A03132, A03133	12 to M.S.	GS 9-11 Civ. E6-04 Mil.	Personnel Proponent	Educated Determination	Compar. Based Task-Based	Task & Job Req.	1 to 6 weeks
Personnel Characteristics Tool	A02121	12 to M.S.	GS 9-11 Civ. E6-04 Mil.	Combat Developer	Conceptual Determination	Compar. Based Task-Based	Abilities & Skills Task & Job Req.	1 to 6 weeks
Manpower Estimation Tool	A02211, A02212	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Combat Developer	Conceptual Determination	Stat. Based Task-Based Compar. Based	Subjective Data Data Bases Budgeting Data Task Data	4 to 5 weeks
Personnel Req. Determination Tool	A02231, A02232, A02233, A02234, A02235	12 to M.S.	GS 9-11 Civ. E1-04 Mil.	Combat Developer Personnel Proponent	Conceptual Determination	Stat. Based Compar. Based Task-Based	Manpower Req. Notional ICTP	3 days
High Driver Tradeoff Analysis Tool	A0224	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Combat Developer	Educated Determination	Stat. Based Compar. Based Task-Based	Manpower Req. Personnel Req. Personnel Char. Notional ICTP	1 - 2 weeks
CMF Impact Tool	A0231, A0232, A0233	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Combat Developer	Conceptual Determination	Compar. Based Task-Based	MOS Notional Plan	7 days
CMF Impact Tradeoff Tool	A0234	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Combat Developer	Educated Determination	Compar. Based Stat. Based Task-Based	CMF MPT Data Outputs	7 days
Position Data Analysis Tool	A03111, A03112, A03113	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Personnel Proponent	Educated Determination	Stat. Based Compar. Based		1 to 3 weeks
Personnel Data Analysis Tool	A03121, A03122, A03123, A03124	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Personnel Proponent	Educated Determination	Stat. Based Compar. Based	Task Data Accession Prediction	1 week
MOS-Training Impact Tool	A0314a1, A0314a2, A0314a3	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Training Developer	Educated Determination	Stat. Based Task Based Compar. Based	Task Based ICTP	18 mos. for ITP & POI CAD & TTHS 2 wks.
Physical Demands Assessment Tool	A0314b2	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Personnel Proponent	Educated Determination	Observ.-Based Compar. Based Simul. Based	Task Data Occ. Sur. Data POI Task Manuals	2 to 3 weeks
Recruiting Eval. Tool	A03151, A03152	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Personnel Proponent	Educated Determination	Compar. Based	Exist. Recruit. Data Pos. Data Anal. Trng. Anal. Results Phys. Demands Anal. Results	4 to 10 days
Pre-SGA Tradeoff Tool	A0316	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Personnel Proponent	Percise Determination	Compar. Based Stat. Based	Exist. Recruit. Data Pos. Data Anal. Trng. Anal. Results Phys. Demands Anal. Results Recruit. Anal. Results	2 to 3 days not major input
SGA Development Tool	A0321, A03122, A0323	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Personnel Proponent	Educated Determination	Stat. Based Compar. Based	MOS Action Plan Task Data	2 to 3 weeks
Post SGA Tradeoff Tool	A0324	12 to M.S.	GS 9-11 Civ. E7-04 Mil.	Personnel Proponent	Precise Determination	Stat. Based Compar. Based	MOS Career Path Supv. MOS Pos. Subord. Grading Patterns	2 to 3 weeks

Table 2

Ten Characteristics Used to Describe Each Required Analytical Method

Method:	An analytical technique or class of techniques required in the process of MOS Restructuring for effective force integration.
Step:	The analytical step in the MOS Restructuring Process where the tool is required.
Purpose:	The purpose of the tool.
Outputs:	The required result of the analytical tool. The result must be consistent with the needs of the next subsequent analytical step.
Linked step or steps:	The subsequent step(s) that must utilize the outputs of the analytical method.
Principal User:	Defines the audience or end user who will utilize the tool during MOS Restructuring. Characteristics include Educational Background, Grade Level, and Principal Agency (Combat Developer, Training Developer, and Personnel Proponent).
Required Precision of Results:	There are 3 levels of precision required during the MOS Restructuring Process. They are as follows: 1) Conceptual Determinations: Decisions regarding feasible solutions, and postulated needs. These decisions occur in the planning process in a minimum constraint environment. 2) Educated Determinations: Decisions regarding notional requirements made in the context of additional constraints to achieve a more refined decision. These decisions occur in the programming process as requirements are made more realistic and affordable. All tradeoff decisions are made at this level of precision at a minimum. 3) Precise Determinations: Decisions regarding requirements that are used for documentation in requesting resources.
Analytical Techniques:	There are 4 basic types of analytical tools required during MOS Restructuring. Particular analysis steps require one or a combination of these techniques for the tool to be effective. The techniques are as follows: 1) Statistical: Mathematical modeling or the development of algorithmic descriptions of dynamic relationships. This allows iterative adjustment of mathematical parameters for an increased understanding of the system. 2) Simulation: This includes both dynamic and static simulations of performance. 3) Comparability: This technique involves the decomposition of systems into subsystems and subfunctions that correspond to data on predecessor or similar subsystems and subfunctions. Through a process of systematic comparison, determinations can be made regarding a change. 4) Task based: This technique involves analysis of aggregated human performance tasks. Such analyses involve the assessment of cognitive and physical workload, time sequence, and support considerations for the allocation of task and MPT requirements.
Data Input Characteristics or Types:	The data characteristics or data types required by MOS restructuring that must be utilized by the analytical tool.
Response Capability:	The response time or turn around time that must be met by the analytical tool to ensure the efficiency of the MOS Restructuring Process.

be essentially the same, with only a slight change in orientation. Thus, it may be possible to develop a single Tasked-based Evaluation Tool to use in all applications, rather than several separate tools. The feasibility of this approach is discussed further in the next section.

A tool would first be required at the initiation of requirements-based restructuring. The purpose of the tool at this stage is to assist in the development of an occupational concept based on the projected task demands. The tool would produce a revised task list consistent with the grade and skill level structures of the Army. These data feed the initiation of High Driver Analysis.

A Task-based Evaluation Tool is also required within the context of requirements-based MOS Training Analysis. The purpose of the tool in this context would be to assist in the development of a training concept by identifying the tasks to be trained. These data would feed the formal development of a notional System Training Plan (STRAP).

The final utilization of a Task-based Evaluation Tool would be in the context of identifying MOCS Identifier Duties and Tasks as part of the operations-based process. This evaluation results in a precise determination of MOCS identifiers and tasks that feeds both Pre-SGA Trade-off Analysis and the development of formal documentation of the MOS action.

Manpower Estimation Tool. This tool would be used at the MOS level to determine the number and skill levels of positions needed and the distribution of workload between these skill levels. This estimation is required during Manpower Analysis in support of the requirements-based process. The resulting estimation would be weighed against the results of Personnel and MOS-Training Analysis during High Driver Trade-off Analysis.

Personnel Requirements Determination Tool. A Personnel Requirements Determination Tool is required at the MOS level during MOS Personnel Analysis as part of high driver analysis. This tool would utilize results from Manpower and MOS Training Analysis to determine the personnel supportability of these decisions. The tool would provide a conceptual estimate of the personnel resource requirements and personnel characteristics needed to support estimates of manpower and training. These data would be weighed against the results of MOS Training and Manpower Analysis during High Driver Trade-off Analysis.

Personnel Characteristics Tool. This tool would be utilized to assess the suitability of projected personnel inventories to meet the job requirements of the new or modified MOS in terms of Armed Services Vocational Aptitude Battery (ASVAB) scores, and knowledge, skills, and abilities (KSAs). This tool is required

to ensure that soldier (job level) capabilities are consistent with job requirements resulting from the change. Where there are incompatibilities, the tool would also be required to assist the analyst in determining ways to reduce or eliminate the inconsistencies. This tool would drive the selection of an MOS during Task-based Analysis and would be used during MOS Personnel Analysis to address MOS ability types and levels. Personnel characteristics data would also be weighed against the results of training, manpower, and personnel requirements analysis during High Driver Trade-off Analysis.

High Driver Trade-off Analysis Tool. The purpose of the High Driver Trade-off Analysis Tool would be to provide the analyst with the capability to identify and assess MPT trade-offs related to MOS restructuring at the MOS level. The systematic use of such a tool would allow the analyst to optimize the MOS and associated support structure from an MPT perspective. The tool would provide a vehicle for refining MPT decisions regarding the developing MOS, making these decisions more realistic. The trade-off tool would utilize the independent conceptual MPT determinations made during high driver analysis and produce an educated, integrated MOS Notional Plan. This plan would provide the baseline for the analysis of CMF variables during CMF Impact Analysis.

CMF Impact Tool. The CMF Impact Tool would use the data provided in the MOS Notional Plan to assess the impact of the MOS design on the Army's force structure (CMF level). MPT determinations would be made at the macro CMF level of analysis. The focus of the tool would be to provide the analyst with the ability to resolve supportability issues at the CMF level. These data would provide a baseline for trade-off analysis between separate MPT interests at the CMF level.

CMF Impact Trade-off Tool. This tool would provide the analyst with an ability to evaluate the conceptual MPT solutions, determined in preceding MOS level steps, at the CMF level and make appropriate trade-offs. The tool would utilize results from the implementation of the CMF Impact Tool and produce an integrated Preliminary MOS Design that addresses the CMF level supportability issues for the developing MOS. These data would then be combined with data from the MOS Notional Plan in the next step to produce an MOS Action Plan, the final product of the requirements-based process.

Position Data Analysis Tool. A Position Data Analysis Tool is required as the first step in the operations-based process. The tool would be designed to assist the analyst in MOS level determinations regarding: 1) health of the MOS; 2) types and numbers of organizations in which the MOS is found; 3) the geographic location and parent organizations of the MOS; and 4) the total number of positions and required grade structure of the

MOS. The sum of these results would be a composite picture of the MOS that would be used in further operations-based analysis including Personnel Data Analysis, Recruiting Analysis, and Pre-SGA Trade-off Analysis.

Personnel Data Analysis Tool. This tool would provide a vehicle for MOS level determinations of: 1) MOS outyear projections; 2) MOS SIMOS implications; 3) the impact of women in the Army on the MOS; and 4) the MOS accession point. The tool would be used during Personnel Data Analysis as part of the operations-based process. These findings would then be utilized in the determination of physical demands and recruiting evaluation. The findings would also be used and evaluated in Pre-SGA Trade-off Analysis.

MOS-Training Impacts Tool. The MOS-Training Impacts Tool would be used during training analysis in the operations-based restructuring process. The tool would provide baseline data for the development of a final training strategy. The tool would use the notional STRAP created during the requirements-based process and make MOS level determinations regarding the: 1) Program of Instruction (POI); 2) Course Administrative Data (CAD); and 3) TTHS account or instructor requirements. Findings from the use of this tool would be evaluated during Pre-SGA Trade-off Analysis.

Physical Demands Assessment Tool. This tool would be utilized by the analyst to determine the physical demands requirements of the MOS. The results of such a tool would be an accurate assessment of the physical demands for all skill level 1 tasks for the MOS. These job level data would be used during the Pre-SGA Trade-off Analysis.

Recruiting Evaluation Tool. A recruiting evaluation tool would be used to assess the impact of a new or revised MOS on existing recruiting practices and to develop revised MOS level recruiting plans. This tool would assist the analyst in the determination of new accession criteria and in revising current JOIN information. These data would be used in Pre-SGA Trade-off Analysis.

Pre-SGA Trade-off Tool. This trade-off tool would be used at the MOS level to ensure that the MOS Action Plan used in SGA Analysis and Development is a balanced, realistic, affordable approach prior to final SGA development. The tool would be used by the analyst to systematically evaluate trade-offs between personnel data, position data, training, physical demands, and recruiting. Adjustments would be made if necessary and an Adjusted MOS Action Plan would be developed as an input to SGA Analysis and Development. This document would also be used to develop final documentation of the proposed AR 611-1 MOS Action. This Adjusted

MOS Action Plan would contain all supporting data from the previous operations-based steps.

SGA Development Tool. The SGA Development Tool would be designed to assist the analyst in the development of grade structures at the MOS level that would meet mission requirements and optimize the career pattern of the MOS. The primary input for this tool would be the Adjusted MOS Action Plan developed through previous steps. The SGA Development Tool would be used to develop a career path and determine the required supervisory and subordinate MOS positions. These data provide the baseline for subsequent Post-SGA Trade-off Analysis.

Post-SGA Trade-off Tool. This tool would provide a vehicle for the analyst to critically evaluate the results of SGA Analysis and Development. The analyst would be provided a systematic method of ensuring a balance between supervisory positions, subordinate positions, grade structuring, and career path. This tool would be used at both the MOS and CMF levels of analysis. The results from this trade-off analysis would represent the SGA data input to the development of documentation of the proposed AR 611-1 MOS Action.

MOS Restructuring Tools: Common Features

Each of the tools outlined above require unique characteristics resulting from the specific analytical requirements of a given function. Since these individual MOS restructuring tools will ultimately be used in the performance of a single common process, meeting the requirements of that single process is also necessary. Outlined below are brief descriptions of those features common to MOS restructuring tools.

Modularity. Each of the tools described has pre-defined boundaries of analysis that evaluate unique aspects of the MOS restructuring question. For the MOS restructuring process to be successful, these boundaries of analysis should not be crossed. There is considerable potential for confusion and confounding of results if the same aspects of the restructuring problem are evaluated by several tools or methods, each with a slightly different focus. This issue becomes critical when one seeks to employ existing methods within the context of a new problem or in conjunction with new or developing tools and methods. The designers of tools or methods should exercise considerable care to minimize analysis overlap for the complex process of MOS restructuring.

Format of results. The functional architecture of the MOS restructuring process reveals a complex network of analyses driven by an equally complex network of data requirements. In the evaluation of existing methods and in the creation of new methods, consideration should be given to the format of results.

Analysis results must be formatted to meet the analytical requirements of subsequent steps. This will ensure that the data are easily accessed and interpreted during other functional steps.

Validity. The MOS restructuring process can be triggered by a variety of changes within the Army. Tools and methods for restructuring must therefore be designed to generate findings that can be generalized to account for various operating environments of the Army. Care must be taken to develop analytical tools that provide valid data regardless of the operating environment (conclusions must be externally valid).

This external validity is achieved through the development of tools that are not excessively specialized. The process, analytical tools, and data requirements should be designed to remain the same regardless of the specific milestones of a given program.

Each MOS restructuring tool should also be designed to maintain internal validity - i.e., the elimination of biases that might invalidate conclusions drawn from the use of the tool. Tools should be designed to eliminate or control potential nuisance variables that may influence results and conclusions. For example, data requirements should be standardized between and within analytical functions and the tools should be applied in a systematic, replicable manner.

Flexibility. The tools and methods designed or selected for use in MOS restructuring must be able to function within the context of imperfect data sources. MOS restructuring has historically been conducted "on-the-fly" and the tools must provide a systematic approach that does not unnecessarily degrade the timely implementation of the program. Tools should be designed to work within an environment of iterative analysis that refines results as additional data become available. Trade-off methods must be flexible enough to work with partial data since trade-offs occur throughout the process of MOS restructuring.

Audit trails. All MOS restructuring tools should provide clearly defined audit trails that respond to each of the analytical requirements of a given function. Audit trails provide a vehicle from which to validate both the correct implementation of the tool and the subsequent results or conclusions.

Existing Methods

The major outputs of the systems engineering analysis were the identification of analytical and data requirements to support the MOS restructuring process. These findings allowed the creation of requirements for analytical methods. Through a comparison of these requirements with the features of existing analytical methods, the researchers were able to determine the feasibility of using existing analytical methods in the process of MOS restructuring. This section describes the assessment of existing methods and the rationale used to make decisions regarding the potential utility of existing methods in MOS restructuring. Specific requirements for further examination of the characteristics of existing methods are also documented.

Initial Assessment of Existing Methods

Through a review of the current literature on MPT methods and tools, an initial comprehensive list of 59 tools was created. This list included all MPT tools that had potential utility in the process of restructuring an MOS. The criteria for initial selection were very broad and the list is shown in Table 3.

Working from this list, the techniques used by the listed tools were examined. Tools inconsistent with the requirements of the MOS restructuring process were eliminated and the initial list was reduced to 18 tools. This reduced list, shown in Table 4, provided the baseline for further analysis of the specific features and characteristics of existing tools.

Literature regarding the selected MPT tools and methods was reviewed and the features of existing tools were recorded. The literature often lacked specific mention of the ten characteristics used to define the MOS restructuring required analytical methods. Often, some interpretation was required to obtain a list of existing characteristics for a given tool or method. Nevertheless, some characteristics of certain existing tools remained undefined. This, however, did not preclude an evaluation of the documented characteristics of existing tools in regard to the requirements of MOS restructuring.

Characteristics of existing tools were compared with characteristics of the required analytical methods. Both specific and process requirements were examined to determine the utility of using existing tools in MOS restructuring. Modularity was not examined as this requirement must be evaluated after decisions are made regarding the use of existing methods. Once these decisions are made, an analysis of the combinations of existing methods and newly developed or modified methods can be conducted to ensure modularity.

Table 3

Initial List of Existing MPT Tools and Methods

A Computer Graphics Simulation of an Aircraft Maintenance Technician (CREW CHIEF)
Addressing Manpower, Personnel and Training (MPT) Issues in Human Factor Engineering Analysis (HFEA)
Air Force Specialty (AFS) Impact Model (AIM)
Army Manpower Cost System (AMCOS)
Authoring Instructional Material (AIM)
Authorization Projection Model (APM)
Budget/Readiness Analysis Technique (BRAT)
Cognitive Requirements Model (CRM)
Comprehensive Occupational Data Analysis Programs (CODAP)
COMputerized BIomechanical MAN-Model (COMBIMAN)
Controlling Operator Workload in Army Systems Design and Evaluation
Cost Oriented Resource Estimating (CORE)
Crew Requirement Definition Subsystem (CRDS) and Methodology
CREWCUT
Early Comparability Analysis (ECA)
Electronic Aids to Maintenance (EAM) Impact on Weapons System Availability
Embedded Training (ET) Guidelines and Procedures
Equipment Domain Methodology
HARDMAN III
  Manpower-Based System Evaluation Aid (MAN-SEVAL)
  Manpower Capabilities II (MANCAP II)
  Manpower Constraints Aid (M-CON)
  Personnel Constraints Aid (P-CON)
  Personnel-Based System Evaluation Aid (PER-SEVAL)
  System Performance and RAM Criteria Aid (SPARC)
  Training Constraints Aid (T-CON)
High Training Transfer (HITT) Training Methodology
Human Operator Simulator (HOS IV)
Job Abilities Assessment System (JAAS)
Job Assessment Software System (JASS)
Logistics Composite Model (LCOM)
Logistics Support Analysis (LSA)
Man-Integrated Systems Technology (MIST) HARDMAN II
Manpower Standards Development System (MSDS)
Manpower Standards Development System (MSDS)
MANPRINT Handbook for Conducting Analysis of the Manpower, Personnel and Training (MPT) Elements for a MANPRINT Assessment
MANPRINT Handbook for Non-Developmental Item (NDI)
MANPRINT Handbook for Request for Proposal (RFP) Development
MANPRINT in Requirements Documents
MANPRINT in Test and Evaluation
MANPRINT Practitioners Guide
MANPRINT Primer
MANPRINT Reference Retrieval System (MANRRS)
MANPRINT Risk Assessment (MRA)
Manufacturers MANPRINT Management Plan (MMMP) Expert System
Methodologies for Planning Unit and Displaced Equipment Training
Military Occupational Classification Structure (MOCS) Handbook
Operations and Maintenance Requirements Simulation Methodology Model
OWLKNEST
Position Data Analysis Job Aid (PDAT-JA) Prototype Software
Requirements Identification and Technology Assessment Summary (RIATAS)
Simulation Network (SIMNET)
Small Unit Maintenance Manpower Analysis (SUMMA)
Specialty Structuring System (S^3)
Supply Support Methodology and Model
System Analysis (SA)
Systematic Organizational Design (SORD)
Systems Approach to Training (SAT)
Task Commonality Analysis Model (TCAM)
TAWL Operator Simulator System (TOSS)
Taxonomic Workstation System (TWS)
Training Analysis Support Computer System (TASCS)
Training Contract Action Data Base (TCADB)
Training Decision System (TDS)
Training Equipment Data Base (TEDB)
Training for Maintenance (TRANSFORM)

Table 4

Reduced List of Existing MPT Tools and Methods

Addressing MPT Issues in HFEA
Air Force Specialty (AFS) Impact Model (AIM)
Army Manpower Cost System (AMCOS)
Cognitive Requirements Model (CRM)
Early Comparability Analysis (ECA)
Embedded Training (ET) Guidelines and Procedures
Equipment Domain Methodology
HARDMAN III
Job Abilities Assessment System (JAAS)
Man-Integrated Systems Technology (MIST)
Manpower Capabilities II (MANCAP II)
Methodologies for Planning Unit & Displaced Equipment Training
Military Occupational Classification Structure (MOCS) Handbook
Position Data Analysis Job Aid (PDAT-JA)
Small Unit Maintenance Manpower Analysis (SUMMA)
Specialty Structuring System (S^3)
Systematic Organizational Design (SORD)
Task Commonality Analysis Model (TCAM)

Each existing tool examined is detailed below along with a discussion of its feasible use in the process of MOS restructuring. Table 5 provides a summary of the capability of existing methods to comply with the required analytical methods of the MOS restructuring process.

Addressing Manpower, Personnel, and Training (MPT) Issues in Human Factors Engineering Analysis (HFEA). This tool, owned by the government, is composed of a flowchart with narrative instructions designed as an aid in preparing the MPT portions of HFEA. Equipment required for use of this tool varies depending on the availability of existing data. If data are not available, the process is restricted to logical analysis of anecdotal data and no equipment is required. If data are available, then equipment is needed to conduct statistical analyses.

Inputs to this aid include: soldier aptitude data (ASVAB profiles), training data (cost, time, end of training comprehension scores), and soldier performance data (time and accuracy in performing various critical tasks). These data are used to produce a matrix of soldier performance related to ASVAB composite scores and a depiction of training resources consumed. These findings are used to estimate system effectiveness and availability as a function of job level MPT requirements. Conclusions are then made with regard to the impact fielding the system will have on existing Army resources (Bogner, 1988).

The tool is strongly oriented toward increasing a system's effectiveness and does not map directly to the needs of any of the MOS restructuring required tools. However, the tool may have some utility in developing aspects of a Job Requirements Comparability Tool for selected restructuring actions. Aspects of the aid may be adapted for early analysis and estimation of effective MOS design. These data may be useful during MOS Restructure Assessment (IDEFo A01) where the effectiveness of various MOS design alternatives is examined. The significance of modifications in the existing methodology must to be determined through a systematic research effort. More specifically, these characteristics must be examined:

- The overall feasibility of the approach in MOS restructuring;
- Modifications required to build a baseline method;
- The effective transition from a measure of systems effectiveness to a measure of MOS effectiveness;

Table 5

The Capability of Existing Methods to Comply with the Required Analytical Methods of MOS Restructuring

	Job Requirements Comparability Tool	Task-based Evaluation Tool	Personnel Characteristics Tool	Manpower Estimation Tool	Personnel Requirements Determination Tool	High Driver Trade-off Analysis Tool	CMF Impact Tool	CMF Impact Trade-off Tool	Position Data Analysis Tool	Personnel Data Analysis Tool	MOS-Training Impacts Tool	Physical Demands Assessment Tool	Recruiting Evaluation Tool	Pre-SGA Trade-off Tool	SGA Development Tool	Post-SGA Trade-off Tool
Addressing MPT Issues in HFEA	P	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Air Force Specialty (AFS) Impact Model (AIM)	–	–	–	–	–	–	P	–	–	–	–	–	–	–	–	–
Army Manpower Cost System (AMCOS)	–	–	–	–	–	–	–	–	–	–	–	–	–	P	–	–
Cognitive Requirements Model (CRM)		–	P	–	–	–	–	–	–	–	–	–	–	–	–	–
Early Comparability Analysis (ECA)	P	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Embedded Training (ET)	–	P	–	–	–	–	–	–	–	–	P	–	–	–	–	–
Equipment Domain Methodology	P	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
HARDMAN III	–	P	–	P	P	P	–	–	–	–	–	–	–	–	–	–
Job Abilities Assessment System (JAAS)	–	–	P	–	–	–	–	–	–	–	–	–	–	–	–	–
Man-Integrated Systems Technology (MIST)	–	P	P	P	P	–	–	–	–	–	P	–	–	–	–	–
Manpower Capabilities II (MANCAP II)	–	–	–	P	–	–	–	–	–	–	–	–	–	–	–	–
Methodologies for Planning Unit & Displaced Equip. Trng.	–	–	–	–	–	–	–	–	–	–	P	–	–	–	–	–
Mil. Occup. Classification Structure (MOCS) Handbook	–	–	–	–	–	–	–	–	–	–	–	F	–	–	–	–
Position Data Analysis Job Aid (PDAT-JA)	–	–	–	P	–	–	–	–	F	–	–	–	–	–	–	–
Small Unit Maintenance Manpower Analysis (SUMMA)	–	–	–	–	–	P	–	–	–	–	–	–	–	–	–	–
Specialty Structuring System (S3)	–	–	–	–	–	P	–	–	–	–	P	–	–	–	–	–
Systematic Organizational Design (SORD)	–	–	–	–	–	P	–	–	–	–	–	–	–	–	–	–
Task Commonality Analysis Model (TCAM)	P	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Requirements of Analytical Tool
P - Partially Addressed
F - Fully Addressed

- User requirements that are consistent with those of the MOS restructuring process;

- Adequate response capability; and

- Outputs for the subsequent restructuring step(s).

Air Force Specialty (AFS) Impact Model (AIM). AIM is a conceptual model developed to overcome shortcomings in the Air Force's Small Unit Maintenance Manpower Analysis (SUMMA) model. SUMMA is a closed loop model that can be used to identify alternative Air Force specialty (AFS) job structures (Akman & Boyle, 1988). Details of SUMMA are discussed later in this paper. However, a major weakness in the SUMMA model is that its optimization criteria for job structuring are limited to several relatively crude measures related to training impact and task burden.

AIM does not take issue with SUMMA's decision model but focuses on the larger decision framework in which specialty structuring decisions must be made. In particular, AIM lays out requirements and procedures to assess and modify SUMMA solutions in terms of personnel policy, career field management, and AFS distribution early in the acquisition process.

In terms of policy, AIM presents concepts for evaluating potentially optimal task structures in terms of unit level and force policy. Career field management impact is assessed through evaluation of ASVAB requirements, accession and retention rates, training requirements, overseas rotation, and paygrade distribution. Impacts on AFS distribution are evaluated in terms of the weapon systems that use the AFS.

The value of using AIM in MOS restructuring is in assessing the impact of MOS design on the Army's force structure. This capability is consistent with the requirements of the CMF Impact Tool for MOS restructuring. A CMF Impact Tool is required to evaluate the MOS design refined through High Driver Trade-off Analysis and specified in the MOS Notional Plan. AIM may have particular utility in this context since the AIM model uses SUMMA outputs as inputs.

The SUMMA model is recommended later in this paper as a model for the development of select aspects of the High Driver Trade-off Analysis Tool that would produce the MOS Notional Plan. Thus, the use of AIM in CMF Impact Analysis (IDEFo A023) would exploit the logical, valid coupling of the two methodologies. No modification in the format of results would be required to transition from MOS analysis to CMF analysis.

Research is needed to determine the value of AIM as a baseline for future development both as a single methodology and within the context of SUMMA. Specifically, analysis is needed to resolve the following characteristics:

- Outputs for subsequent restructuring step(s);
- Output precision required in MOS restructuring;
- User requirements that are consistent with those of the MOS restructuring process; and
- Adequate response capability.

Army Manpower Cost System (AMCOS). AMCOS is a personnel computer (PC) based tool used to forecast manpower costs for the life cycle of proposed weapons systems (Bogner, 1988). The tool utilizes manpower projections by grade and MOS among other inputs to produce estimates of MOS level MPT costs by year. Budget appropriation categories are also produced. AMCOS is owned by the government.

AMCOS is a series of related models for developing economic (real) and budgetary personnel cost estimates over the career of the enlisted soldier. Marginal and total cost projections are generated at the unit and soldier levels.

The life cycle cost model of AMCOS provides additional cost analysis for recruiting, enlistment bonuses, equipping, initial entry training (IET) and advanced individual training (AIT), and accession-related permanent change of station (PCS). The AMCOS research and development program has established a basis for effective cost projection algorithms and provides a source of life cycle cost data that may be useful in optimizing MOS decisions. Consequently, AMCOS may be useful in addressing the cost implications of alternative MOS structures considered during Pre-SGA Trade-off Analysis (IDEFo A031).

As a central component of building a Pre-SGA Trade-off Tool, AMCOS represents a viable method of ensuring that an MOS design is balanced, realistic, and affordable prior to SGA development. The method represents a precise vehicle for the personnel proponent to use in addressing cost issues and trade-offs as part of developing the Adjusted MOS Action Plan.

Further research is required to verify the utility of the tool as a baseline for development of the Pre-SGA Trade-off Tool within the constraints of AR 611-1 and the MOCS Handbook. Research should address the following characteristics:

- Outputs for the subsequent restructuring step(s);

- Output precision required in MOS restructuring; and
- User requirements that are consistent with those of the MOS restructuring process.

Cognitive Requirements Model (CRM). CRM (a proprietary product) provides system developers with information on the cognitive demands of system tasks. The tool accomplishes this by breaking tasks down into component processes and then integrating those components into a single index of task difficulty. A set of 12 rating scales are used to assess job level cognitive factors of the component processes prior to the use of an evaluation algorithm that converts the scaled values into a measure of task difficulty. The tool provides estimated skill requirements and overall measures of task difficulty with regard to cognitive requirements. The methodology should be considered in further development of select aspects of the Personnel Characteristics Tool used during both Task-based Analysis (IDEFo A021) and MOS Personnel Analysis (IDEFo A0223). However, further research is required to resolve at least the following characteristics:

- User requirements that are consistent with those of the MOS restructuring process;
- Adequate response capability;
- Outputs for the subsequent restructuring step(s); level of precision, utility in restructuring; and
- Availability of data inputs.

Early Comparability Analysis (ECA). The ECA methodology was developed to assist system developers and combat developers make conceptual job level MPT determinations early in the system acquisitions cycle. The tool (owned by the United States Army Personnel Integration Command) is used immediately following the development of the Concept Based Requirements System (CBRS). The ECA methodology is a hard copy guide that walks the analyst through 12 analytical steps. A lessons learned approach is used to identify deficiencies in previous systems that resulted in poor task performance. In addition to identifying system deficiencies, ECA also incorporates comparisons of comparable tasks. The results of ECA include preliminary MPT constraints, a conceptual target audience description, and theorized MPT high driver tasks for the new system. These determinations are made prior to the development of design requirements.

The ECA methodology is currently available and the features presented above are consistent with most of the analytical requirements of the Job Requirements Comparability Tool. Although not all requirements are met, the ECA methodology does

provide a baseline vehicle for the systematic examination of job designs during the MOS Restructure Assessment (IDEFo A01). The current configuration of the methodology could be tailored to the specific needs of the Job Requirements Comparability Tool.

The ECA methodology also appears to be consistent with the process requirements of MOS restructuring. ECA is a flexible, iterative process that refines determinations as available data mature. ECA provides a defined audit trail of the decision process. The determinations made during ECA thus provide easily interpreted data inputs to the requirements-based restructuring process. However, before the tool can be applied in effective MOS Restructure Assessment, the following characteristics must be resolved:

- Required tailoring of the ECA approach;
- Availability of required data inputs;
- Adequate response capability; and
- Expansion to account for supervisory and management tasks.

Embedded Training (ET) Guidelines and Procedures. The ET Guidelines and Procedures are contained within ten related documents intended for use by combat developers, training developers, and system developers. The documents provide systematic procedures and guidelines for effective consideration, development, and integration of ET capabilities into existing and developing systems. The ET guidelines and procedures are owned by the government.

The procedures utilize information regarding the mission, tasks to be performed, interface requirements, and comparable systems to perform task-based and comparability-based analyses. From these analyses, job level and MOS level decisions are made regarding the feasibility of incorporating ET into a given system. The procedure used to process these various inputs may vary depending on the objective of the analysis. Each of the ten documents outlines procedures of different functional analyses. From these analyses, the analyst can make decisions regarding the feasibility of integrating ET into a system and develop a strategy for ET implementation.

ET has been mandated as the first alternative in the selection of training for any new system (Bogner, 1988). As such, the ET guidelines and procedures are appropriate for MOS Training Analyses (IDEFo A0222) conducted for restructuring actions resulting from the introduction of new or modified equipment. The ET procedures and guidelines should therefore be used as a model for building select aspects of the Task-based

Analysis Tool for training. How this is to best be accomplished within the context of MOS restructuring is yet to be determined. Specifically, issues involving the following must be resolved:

- The effective coupling of ET with other companion methodologies for developing an initial training concept for MOS restructuring;
- Adequate response capability; and
- Outputs for the subsequent restructuring step(s).

Equipment Domain Methodology. ARI has conducted initial research into the feasibility of using equipment domains as a vehicle for making determinations regarding the existence of a restructuring condition. This objective is consistent with requirements of the Job Requirements Comparability Tool to be developed for MOS Restructure Assessment (IDEFo A01). It is during these steps that initial decisions are made regarding the need for restructuring or creating a new MOS.

The methodology focuses on the equipment side of the man-system relationship and makes restructuring determinations based on the clustering of similar equipment items. In theory, equipment items having similar attributes would fall within a common domain. The characteristics of the domain are defined by various soldier performance or job level variables. Each domain is thus associated with a MOS or set of MOSs . As an attempt is made to classify new or modified equipment within established domain clusters, decisions regarding needs for MOS restructuring and the creation of new MOSs and domains become apparent.

This equipment oriented approach may have particular value in assessing the need to restructure MOSs in response to materiel acquisition. Therefore, the Equipment Domain Methodology may have value in developing materiel acquisition related aspects of the Job Requirements Comparability Tool. However, considerable research is still to be conducted in fully developing the methodology. The Equipment Domain Methodology should only be considered after it has been validated as a viable approach.

HARDMAN III. Currently under ARI development, this tool consists of seven related PC-based tools that assist the analyst in the development of MPT estimates early in the acquisition process. These tools will assist the Army analyst in developing systematic descriptions of system performance requirements, manpower constraints, and manpower and personnel characteristics requirements at the weapon system level (Kaplan & Hartel, undated). The tool is being developed for use by the combat and training developers. Descriptions of the seven components follow.

The System Performance and RAM Criteria Aid (SPARC) is being designed to develop individual system performance requirements based on 21 different simulation models representing major classes of Army systems. System performance may be mapped from unit performance requirements using the Blueprint of the Battlefield Taxonomy (TRADOC PAM 71-9).

The Manpower Constraints Aid (M-CON) provides maximum crew size constraints so that equipment designers develop designs with manning requirements not exceeding the constraints. The model is based on predicting MOS availability. Requirements are projected against the expected MOS population until there is consistency between new and existing demands as well as supply.

The Personnel Constraints Aid (P-CON) provides soldier performance characteristics which can be integrated with other design dimensions. The model deals with soldier characteristics that are MOS sensitive and those that are not. The system predicts ASVAB and mental category (CAT) distributions for each MOS; these are mapped to a series of equations based on the ARI Project A data base. P-CON produces MOS dependent information on age, language, ability, and sex as well as non-MOS dependent information on size, strength, and perceptual abilities for the soldier age group.

The Training Constraints Aid (T-CON) describes probable training so that design requirements will not require skill levels that cannot be achieved by available training. The system provides training hours for operations and maintenance. For operations, T-CON provides training hours per operations function, MOS and course, the general type of training per function, and training difficulty. Maintenance training data include training hours per subsystem, course, and MOS; the general type of training; and training difficulty.

These four models are designed to provide the equipment designer with constraints that translate into equipment performance levels. Equipment is designed to achieve certain performance levels. The HARDMAN constraints indicate the capabilities achievable based on the projected availability of MPT resources. Two models included in HARDMAN III are designed to be used in evaluating system designs.

The Manpower-Based System Evaluation Aid (MAN-SEVAL) is being developed to evaluate designs by determining the jobs and number of personnel per job required to operate and maintain the hardware and software. The Army will then have the basis to determine manpower requirements in comparison to manpower availability.

The sixth product, the Personnel-Based System Evaluation Aid (PER-SEVAL), evaluates designs by determining human

characteristics and the required level of each necessary to operate and maintain a given design to performance criteria. If the average soldier is unable to operate or maintain the system to criterion levels, ASVAB, PULHES, and Military Enlistment Physical Strength Capacity Test (MEPSCAT) scores are raised, and the model rerun until system performance is achieved.

The final product is Manpower Capabilities II (MANCAP II), which can integrate outputs from the Army's HARDMAN III model. MANCAP allows for the synthesis of HARDMAN data developed for a single system to define maintenance, supply, support and manpower requirements in an organizational context.

The HARDMAN III products are relevant to the process of High Driver Analysis (IDEFo A022) in requirements-based MOS restructuring. The methodologies used to produce HARDMAN III products are consistent with many of the requirements of several tools needed during High Driver Analysis. As such, select methodologies may serve as a baseline for tool development. These would include the use of T-CON in developing a Task-based Evaluation Tool for developing a training concept, P-CON in developing a Personnel Characteristics Tool and Personnel Requirements Determination Tool, and M-CON and MANCAP II in the development of a Manpower Estimation Tool. Additionally, the integrated approach of the HARDMAN methods may contribute to the development of an effective, integrated High Driver Trade-off Tool.

However, the extent to which system designs will actually be influenced by the various constraints identified by HARDMAN III has not yet been demonstrated. HARDMAN III may deserve consideration as an analytical approach during High Driver Analysis with selected MOS restructuring actions after the methodologies have been adopted by Army users.

Job Abilities Assessment System (JAAS). JAAS is a decision aid methodology that assists an analyst in the systematic development of an abilities profile for a given job or task. The abilities profile provides a definition of the job or task in terms of the requirements for the people who are going to perform the job. The tool can be used for any human job or task that can be described in a narrative summary.

An additional component of JAAS allows judgments to be made regarding how much of an identified ability is needed for successful job performance. These profiles can then be used in comparisons among JAAS profiles for other MOS job restructuring options, the development of selection criteria, and the development of training requirements. The two components of JAAS provide a vehicle for the assessment of required soldier aptitudes and capabilities during MOS restructuring.

Under government sponsorship, JAAS has been fully developed. Although the tool is not currently used in MOS restructuring, the features of the tool are consistent with the requirements of the Personnel Characteristics Tool used to evaluate job and MOS characteristics to ensure proper MOS selection during Task-based Analysis (IDEFo A021) and to address MOS ability types and levels during MOS Personnel Analysis (IDEFo A0223). Therefore, the methodology should be considered in further development of the Personnel Characteristics Tool. Before JAAS can be utilized, research is needed in the following areas:

- The feasibility of using JAAS as a baseline for developing an MOS selection tool;
- Provisions for adequate response capability;
- Availability of compatible data inputs from which to build narratives with the required level of precision; and
- Output precision required in MOS restructuring.

Methodologies for Planning Unit and Displaced Equipment Training. These methods, which are owned by the government, are utilized to determine the most effective and efficient training methods in terms of resources consumed. Effectiveness is defined in terms of the population trained and efficiency is defined in terms of the projected resources consumed. The methods provide a vehicle for the development of a training plan for organizations scheduled to receive a new system. This plan includes a training schedule for the organization and a depiction of the resources required to support the training program.

The methods are flexible in their design and can produce results at various levels of precision based on the maturity of the data inputs. Alternative training strategies can be investigated and compared quickly through both task-based and statistical analyses. The methodologies can be applied to a single set of courses at a service school or used to determine requirements for a multi-year program.

The inputs utilized in the application of these methodologies include: the target audience description (TAD) of the MOSs selected; the location, size, delivery data, and number of systems to be received; the mission requirements; characteristics of the training required; and estimates of the projected training resources (Bogner, 1988). These inputs are used to develop an initial training schedule or baseline that addresses training requirements, resource requirements, and rates of consumption. The baseline serves as the point from which various training alternatives are computed and training components selected. The model is then applied to each

alternative training design to determine the optimal training plan.

These methods are currently in the prototyping stage. As currently conceived, the methods are consistent with many of the requirements of the MOS-Training Impacts Tool for operations-based restructuring. The methods could potentially be used to develop job and MOS level baseline data for the development of a final training strategy required during Training Analysis (IDEFo A0314a). Further research is needed if the methodologies are to be used as a baseline for development within the constraints of AR 611-1 and the MOCS Handbook. Research should address the following issues:

- Outputs for the subsequent restructuring step(s); and

- User requirements that are consistent with those of the MOS restructuring process.

Man-Integrated Systems Technology (MIST). MIST, which is owned by the government, is an automated system of worksheets and tools designed to assist skilled MPT analysts in determining the job and MOS level MPT requirements of developing systems. This comprehensive front-end analysis tool provides five early MPT estimation functions based on a knowledge of similar systems and technological growth trends. MIST makes MPT determinations largely based on comparability analysis but also uses statistical and task-based analyses where appropriate. Additionally, MIST contains a number of resident MPT data bases as well as the capability to create and update new pre-formatted data bases.

The utilization of MIST involves the processing of numerous combinations of inputs through multiple computer runs. Data inputs are entered into MIST as part of an initial "System Requirements Analysis". This process involves the use of pre-formatted worksheets addressing each of the following data types:

- Acquisition Data;
- Mission Area Analysis Data;
- Functional Requirements Data;
- Engineering Data;
- Manpower Data;
- Reliability Data;
- Maintainability Data;
- Personnel Data; and
- Training Data.

Once entered on the appropriate worksheet, individual data inputs are available for various functional analyses. Data inputs are available for update throughout the life cycle of a

given program and provide an expanded resource for future analyses.

The functional analyses performed through MIST provide a comprehensive projection of MPT requirements consistent with many of the criteria of the requirements-based restructuring process. Once worksheets are completed through System Requirements Analysis, an MPT data baseline exists from which to perform individual functional analyses. These functional analyses can be performed in any order, at varying degrees of detail as required by the analyst. MIST has been designed for ease in conducting iterative analyses that promote the refinement of MPT solutions. Additionally, these iterative analyses are recorded by the system and provide a comprehensive audit trail. The functional analyses performed by MIST include:

- Manpower Requirements Determination;
- Personnel Requirements Determination;
- Training and Resources Determination;
- MOS Selection Aid; and
- Training Media Selection.

Each of these functional analyses provides models that could be used to develop tools for use during requirements-based analysis. Specifically, the existing models provide a baseline for tool development that produces outputs that are valid inputs to the High Driver Trade-off Analysis Process. The Manpower Requirements Determination Model (MRD) calculates the actual enlisted maintenance workload requirements for all maintenance levels. MRD also calculates the levels of manpower for each MOS/ASI that is required to maintain a particular system configuration. Although limited to enlisted maintenance manpower determinations, MRD could provide a model for the development of selected aspects of the Manpower Estimation Tool required during Manpower Analysis (IDEFo A0221). Further analysis is needed to determine if MRD provides the foundation upon which to build a complete Manpower Estimation Tool. Specifically, characteristics for further research would include:

- The feasibility of building upon the MRD methodology as the baseline manpower estimation tool;

- Expansion of the methodology beyond enlisted maintenance personnel;

- User requirements that are consistent with those of the MOS restructuring process;

- Adequate response capability; and

- Outputs for the subsequent restructuring step(s).

The Personnel Requirements Determination Model (PRD) estimates the personnel requirements for each MOS selected to support a given system. Personnel requirements are defined in this context as the quantity of individuals provided and carried in a paygrade to offset losses and support a specified set of manpower requirements. These manpower requirements are determined through MRD and are presented in terms of a specified period of time.

PRD may provide a model for building select aspects of a Personnel Requirements Determination Tool, required in Personnel Analysis (IDEFo A0223). However, PRD does not provide methods for the integration of training analysis results that are required to fully determine the supportability of MPT decisions. To ensure that all requirements are satisfied, research is required in the following areas:

- Modification of the methodology to include training analysis data;
- User requirements that are consistent with those of the MOS restructuring process;
- Adequate response capability;
- Outputs for the subsequent restructuring step(s); and
- Output precision required in MOS restructuring.

The Training Costs and Resources Determination Model (TCR) calculates the resources required for TRADOC institutional courses. As costs and resources are refined, TCR can provide detailed estimates of the training resources required for various configurations of the proposed system. TCR algorithms are based on existing TRADOC data regarding tasks, instructor staffing standards, course requirements data, and Army training costs.

Although TCR outputs are not specifically required by MOS Training Analysis (IDEFo A0222) during MOS restructuring, the data could be useful during High Driver Trade-off Analysis. TCR could provide a model for select aspects of a task-based evaluation tool for requirements-based training analysis.

Like TCR, MIST's Training Media Selection Model (TMS) is not directly required during requirements-based Training Analysis (IDEFo A0222). However, the outputs from this process may again be valuable during High Driver Trade-off Analysis. TMS is a model that objectively evaluates notional task data inputs and assigns a proposed optimum training medium for the assigned tasks. TMS uses a pre-defined training media to psychological variable matrix to evaluate the task inputs. This analysis allows training media that are expensive or require a long lead

time to be identified (e.g., development of a simulator). The following issues need to be resolved if TCR and TMS analyses are to be used to build select aspects of the Task-based Evaluation Tool intended to develop the initial training concept:

- The feasibility and desirability of incorporating these methods with companion methods to produce a notional STRAP;
- User requirements that are consistent with those of the MOS restructuring process;
- Adequate response capability; and
- Outputs for the subsequent restructuring step(s).

The MOS Selection Aid (MSA) provided by MIST is designed to help the analyst make informed decisions regarding MOS requirements. The tool focuses on the qualitative aspects of the MOS selection process and provides requirements for tentative MOS selections. These requirements include determinations regarding the number of tasks, training man-days to support the selection, and required courses for the MOS.

Although the application of the MSA has a qualitative focus, the aid can be used in conjunction with the TCR, MRD, and PRD to gain insights into the quantitative issues of MOS selection. For example, the experienced analyst could use the outputs from the different functional analyses to explore attrition and retention concerns.

MSA is consistent with the analytical requirements for selecting a MOS during Task Aggregation in requirements-based restructuring. Specifically, a qualitative MOS selection occurs during the first step of Task Aggregation (IDEFo A02121). It is during this step that a Personnel Characteristics Tool is required. MSA may provide a model for the development of this tool which is also required to address MOS ability types and levels during MOS Personnel Analysis (IDEFo A0223). However, further analysis is need to determine the utility of using MSA, JAAS, or both in making these qualitative determinations. MSA must be researched further to ensure that the final tool developed for MOS restructuring truly optimizes the evaluation of personnel characteristics. The following issues must be resolved:

- The feasibility of building upon the methodology as the definitive baseline; and
- Provisions for adequate response capability.

MOCS Handbook. Published by Headquarters, Department of the Army, this handbook identifies the key analytical and procedural requirements for the operations-based steps of an MOS restructuring action. To this extent, the handbook is a valuable asset in the process of MOS restructuring (Akman & Haught, 1990). Requirements for position data analysis, personnel data analysis, recruiting impact analysis, MOCS identifier duties and task analysis, training needs assessment, and physical demands analysis are all documented in the handbook. However, with the exception of the average grade matrix, SGA development worksheet, and procedures for physical demands analysis, few job aids or methodologies are described.

Thus, the MOCS Handbook represents more of a constraint than a method or tool in operations-based MOS restructuring. While the operations-based restructuring process is adequately described, the MOCS Handbook is hindered in it's utility as a tool by the absence of explicit methodologies (i.e., tools and aids) that facilitate the execution of analytical and procedural requirements.

The MOCS Handbook provides procedures for a detailed assessment of physical work requirements for entry level MOSs. The purpose of this assessment is to classify each MOS according to job level work requirements as they are to be performed under combat conditions. A physical demands analysis worksheet is used to assist in the assessment of physical demands. The assessment provides for gender free screening of soldiers and fulfills all analytical requirements of the Physical Demands Assessment Tool needed during the Physical Demands Analysis step (IDEFo A0314b) of operations-based MOS restructuring.

Position Data Analysis Job Aid (PDAT-JA). The PDAT-JA is a PC-based prototype system designed to improve operations-based MOS restructuring by reducing the burdens of analyzing the large volumes of data during Position Data Analysis (IDEFo A0311). PDAT-JA has been tailored for this specific application and is designed to enhance the MOS analyst's capability in the analysis process. PDAT-JA does not totally automate Position Data Analysis but assists in the accomplishment of several time consuming analytical steps (Haught & Akman, 1990b). These include:

- Researching TAADS and identifying MOS positions;
- Reviewing PMAD data; and
- Applying the Average Grade Distribution Matrix.

PDAT-JA's ability to operate as an integrated element of the Position Data Analysis process is consistent with requirements for the development of a Personnel Data Analysis Tool. The key to PDAT-JA is its ability to support analysis through rapid data sorting and output reporting (e.g., the overall reduction of

manual data manipulation). PDAT-JA provides the user a systematic procedure for manipulating and retrieving MOS level position data for the purpose of providing structure to the analytical process. This structure provides easily documented findings and a precise audit trail of the decision process.

PDAT-JA provides a solid cornerstone for the development of a Position Data Analysis Tool for MOS restructuring. PDAT-JA is consistent with all analytical requirements of the needed tool and was developed within the constraints of AR 611-1 and the MOCS Handbook for use during the MOS restructuring process.

The prototype PDAT-JA was built for ARI and is under continued development sponsored by ARI. PDAT-JA should continue to be the focus of future efforts in the development of a Position Data Analysis Tool. However, validation of the final PDAT-JA configuration within an operational environment is necessary to secure its place in the operations-based MOS restructuring process.

PDAT-JA may also be useful in requirements-based MOS restructuring. The job aid's capability to model MOS grade structures will enhance MPT planning in terms of net increases or decreases in MOS force structures. Once the total number of MOS personnel requirements are known, the requirements can then be modeled through PDAT-JA. Modeling an MOS in terms of structure will provide insight into accession and training requirements, and general levels of skills needed to support an MOS structure of a particular size. With this information, the capability exists to profile manpower resource requirements as part of Manpower Analysis (IDEFo A0221) during the High Driver Analysis process.

Small Unit Maintenance Manpower Analysis (SUMMA). The SUMMA model developed for the Air Force is a PC-based decision aid intended to portray consequences, or trade-offs, of maintenance job re-definition. This job re-definition typically takes the form of a job merger or job enlargement. SUMMA systematically evaluates alternative job level structures in terms of task content and develops conceptual task and job clusters that have been optimized for a given system. The analysis is performed through the use of a task allocation algorithm that uses task information, SME data, and ASVAB (aptitudes) data as inputs. The Logistics Composite Model (LCOM) data base serves as the source for definition of Air Force task and specialty combinations.

SUMMA is currently available and can be used early in the systems acquisition process by the combat developer. SUMMA provides a flexible analysis tool designed to make iterative trade-off determinations. Through SUMMA, an analyst can examine a limited number of MPT consequences resulting from the implementation of a given restructuring strategy. The logic and

analysis involved in these determinations is recorded in the system to provide an audit trail of resulting conclusions.

The SUMMA model, while lacking an integration of key MPT factors at the unit and force level, was based on a strong logic and analytic foundation for defining alternative job clusters and has been the subject of follow-on development in order to extend its application. These include the development of the Specialty Structuring System (S^3) and AIM. Its concepts and approach, particularly when coupled with S^3 and AIM extensions, have potential relevance to the development of the High Driver Trade-off Analysis Tool used during the trade-off analysis step (IDEFo A0224) of requirements-based MOS restructuring. Further research requirements are discussed together with S^3 requirements.

Specialty Structuring System (S^3). This model is designed to establish a baseline comparison system from which to establish MOS level MPT goals and conduct trade-offs among MPT issues. The development of S^3 was initiated as a follow-on development program to the initial task analysis and clustering methods developed in SUMMA. The development effort is focused on expanding the scope of the original decision model to include personnel and training tradeoff issues when optimizing task and job consolidation (Sorenson, 1988).

The model provides conceptual MPT analysis and is intended for use by Air Force planning personnel during the pre-concept and concept development phases of the acquisition process. The design objective is maximization of work efficiency and minimization of weapon system life cycle support costs.

The completed S^3 system is intended to optimize MOS consolidations at both the unit and weapon system level. As an extension of SUMMA, S^3 may provide a model for select aspects of a High Driver Trade-off Tool to be used in High Driver Trade-off Analysis (IDEFo A0224). However, its utility in developing analytical techniques supporting requirements-based MOS structuring is dependent upon S^3 becoming operational.

Although limited to maintenance restructuring, the SUMMA and S^3 models may together represent a fairly complete baseline for future development of the High Driver Trade-off Analysis Tool. Research into the following issues is needed to substantiate the utility of the methods as a baseline:

- How many and which trade-off combinations can be accounted for through the methodology;

- The development of user requirements that are consistent with those of the MOS restructuring process; and

- Provisions for adequate response capability.

Systematic Organizational Design (SORD). SORD is a method of specifying the composition of Army units and combinations of units to form larger organizational structures in response to changing requirements or constraints. This process is a major factor in the Concept Based Requirements System (CBRS). During CBRS, initial concepts for organizing units are created and incorporated into a document called the Unit Reference Sheet (URS). SORD provides a standardized methodology supporting the organization of units into notional TOEs during CBRS. SORD will soon become the required technique for designing Army units as specified in TRADOC Regulation 71-17.

SORD is intended for use by an experienced combat developer who is a captain or major, or a civilian with comparable military knowledge and experience. SORD assists the expert user in the structured development of a completed URS report starting with the receipt of the unit's mission. SORD prompts the user throughout URS development and user inputs are recorded in pre-formatted working files. Thus, a complete audit trail of the completed URS is created.

There are three major components of SORD, the Mission to Function Subsystem (MFS), the Unit Design Subsystem (UDS), and the Design Evaluation Subsystem (DES). Using these three components, the user enters relevant inputs, design units, and tests various assumptions and alternative unit designs.

The SORD methodology permits the rapid development of alternative conceptual designs early in the unit design process. This capability is consistent with the requirements of High Driver Trade-off Analysis (IDEFo A0224) in requirements-based restructuring.

Although the model is designed to aid in the development of completed URS reports, the methodologies of SORD may have some utility in select aspects of tool development. The tool conforms with many if not all required characteristics of the High Driver Trade-off Tool. The following issues should be further examined:

- The feasibility of using the methodologies as a baseline for development; and

- Modification of the methodology for application during MOS restructuring.

Task Commonality Analysis Model (TCAM). The purpose of the TCAM methodology is to provide an analytical bridge between an initiating event (a change in doctrine, manpower authorizations, or new or modified equipment) and the formal requirements-based restructuring process. In this role, TCAM addresses many of the

analytical requirements of the MOS Restructuring Assessment step of the requirements-based restructuring process (IDEFo A01).

TCAM was developed for ARI to make initial determinations regarding the need for MOS restructuring analysis during a case study of the Battlefield Maintenance System (BMS). As such, TCAM has been developed for use by the combat developer to make early assessments of a potential restructuring condition.

TCAM utilizes equipment task data and SME inputs regarding the general knowledge requirements to perform these tasks (enabling criteria) to make initial determinations regarding task commonalities across MOSs and equipments. These conclusions can then be used to make a restructuring decision and define the scope of future restructuring analyses steps.

TCAM conforms with most of the required characteristics of the Job Requirements Comparability Tool required during MOS Restructure Assessment. The tool therefore represents a potential baseline for development, if only in the realm of changes that impact on the maintenance of inventories of equipment. However, the TCAM model does require validation beyond the context of the BMS case study.

Conclusions

This section has described a number of existing tools that may serve as methodological baselines for future development. These initial determinations were made based on a set of ten characteristics. Of the existing tools described, only two appear to fully address the criteria for analytical tools for MOS restructuring. PDAT-JA appears to address all the criteria of the Position Data Analysis Tool, and the physical demands analysis section of the MOCS Handbook appears to address all criteria of the Physical Demands Analysis Tool. However, PDAT-JA requires validation within the MOS restructuring operating environment. The remaining tools partially address some requirements and demand further analysis as described.

Research Requirements for Analytical Methods

This section outlines the requirements for further research regarding analytical methods for MOS restructuring. While the currently used MOS restructuring process works, it is hampered significantly by the absence of explicit, systematic methodologies (i.e., tools and aids) for the execution of the process. Consequently, MOS restructuring is much less efficient than desired. The need, therefore, exists not to alter the process in any fundamental way but to standardize the process and make it function more efficiently, effectively, and reliably through the creation of analytical tools and job aids. This is the framework in which the following research requirements are presented. This context permits the development of system-oriented methodologies and tools for successful implementation of a total MOS restructuring strategy.

Requirements for the development of restructuring tools are first presented. These requirements address tools that have potential existing baselines and new tools that require a full research and development effort. Following this discussion, a general approach to the development of MOS restructuring analytical methods is presented. This is a generic approach that addresses the steps of performance in building restructuring tools.

Requirements for Tool Development

Few existing MPT tools have been designed to account for issues unique to the MOS restructuring process. Tools must be researched and developed to satisfy the analytical requirements of specific functions performed during MOS restructuring. This developmental research is required in two areas: Tools that can utilize existing methods as a foundation for development and new tools that require "full scale" research and development efforts. The MOS restructuring required analytical tools within both of these categories are outlined below.

Building from an existing methodological baseline. The present effort has identified a number of existing methods that may provide an established baseline for the development of select MOS restructuring analytical tools. These existing methods have been identified to ensure that there is not a duplication of effort in the development of new restructuring tools and as a vehicle for the introduction of a "lessons learned" approach to the development of applicable tools. Required analytical tools having existing methodological baselines will have the benefit of building on knowledge and insights gained through the application of analytical tools with identical or similar objectives. Those

required analytical methods that could conceivably be developed using an existing methodological baseline include:

- Job Requirements Comparability Tool;
- Personnel Characteristics Tool;
- Task-based Evaluation Tool: Training Concept;
- Manpower Estimation Tool;
- Personnel Requirements Determination Tool;
- High Driver Trade-off Analysis Tool;
- CMF Impact Tool;
- MOS-Training Impacts Tool; and
- Pre-SGA Trade-off Tool.

Several of these required analytical methods have more than one existing method as potential baselines. In these instances, if a combination of methods is to be used, potential interactions between the selected methods must be examined. This research should be conducted during the formation of analytical tools to ensure that the product of the development effort functions effectively.

Building new tools. Required analytical methods not having an existing tool to serve as a potential baseline include:

- Task-based Evaluation Tool: MOCS Identifier Duties and Tasks;
- Task-based Evaluation Tool: Occupational Concept;
- CMF Impact Trade-off Tool;
- Personnel Data Analysis Tool;
- Recruiting Evaluation Tool;
- SGA Development Tool; and
- Post-SGA Trade-off Tool.

These required analytical methods require a full research and development effort. This would include the following steps of the general approach to tool development with the exception of the review of existing methods.

Building Analytical Tools: A General Approach

The action or change that ultimately triggers the need to restructure MOSs may initiate within the domain of any Army life cycle functional area (Force Development, Acquisition, Training, Distribution, Deployment, Sustainment, Development, Separation). Each of these functional areas must therefore have access to the proper MPT tools required to respond to restructuring needs. Restructuring MPT tools must function effectively regardless of the functional context in which they are used.

Generally, the emphasis on MPT tool and technique development has only existed within the domain of the materiel acquisition decision process. While MPT tools are critical

during the acquisition process, effective MOS restructuring demands that these or similar methods function productively beyond the confines of materiel acquisition.

Therefore, the approach or orientation of MOS restructuring tool developers must, in general, address generic tools that meet the needs of other applications as well as materiel acquisition. Baseline MOS restructuring methods must be created that are free from constraints imposed by the Life Cycle System Management Model (LCSMM), yet flexible enough to function within these same constraints. With this understanding, the following developmental steps should be executed.

Conceptual design. Before a MOS restructuring tool or job aid can be designed, clear objectives or design goals must be specified. Without carefully stating and designing to these objectives, the resulting tool or job aid could easily be under- or over-designed. If the tool is under-designed, it will not meet the desired analytical requirements. If the tool is over-designed, it will exceed the design objectives, thereby expending unnecessary resources both during tool development and during its use.

Tool designers should develop these design objectives from a careful examination of the completed MOS Restructuring Research and Development Blueprint. The completed blueprint would contain all relevant information regarding the total MOS restructuring systems architecture, responsible agencies, analytical requirements, data resource requirements, data flow, related existing methods, design concepts, priorities, and potential resources required for tool development. These data provide a sound basis for the development of complete design goals consistent with the requirements of MOS restructuring. Thus, entry into the conceptual design phase of tool development assumes that a complete MOS Restructuring Research and Development Blueprint has been produced.

The development of design objectives also implies the development of design criteria that can be used to evaluate the developing tools or job aids. These criteria should be in the form of user-oriented metrics. As such, these criteria should be focused on enhancing real task performance of given functional steps (the way the expected user is to perform his or her job in executing a given MOS restructuring functional (analytical) step). From clearly stated objectives and established performance criteria, conceptual designs of specific tools and job aids can be created with confidence for each of the required analytical methods.

Prototype development. The prototype development step begins an iterative design process where formative evaluation occurs. As the prototype tool or job aid takes form, it is evaluated and

redesigned in an iterative fashion until the desired design objectives are reached. Trade-offs need to be made between various tool configurations (i.e., software, checklists, hardcopy procedural guides, etc.) and the stated design objectives in an effort to optimize the positive impact of the tool on the MOS restructuring process. These trade-offs are critical to the iterative design approach where the results of one trade-off define the issues to be addressed during the next design iteration.

Demonstration and validation of the prototype. Following the completion of prototype development, a final evaluation of the prototype is required. This step consists of the demonstration and validation of the prototype design. This final step in the iterative design process involves some form of user-acceptance testing. This testing must be conducted on the appropriate population of end users in order for the results to be valid. If the stated design objectives are achieved, the development of the final configuration of the tool may begin. If the prototype does not meet the stated objectives, then the iterative prototyping process continues until the objectives are realized.

Development of the tool. This step involves the processing and packaging of the operational version of the tool or job aid. The operational version of the tool is built to the specifications of the concluding prototype design and is subject to a quality control inspection based on these same specifications. The completed tool is then fielded for use during MOS restructuring.

Review common features. The ultimate goal of developing restructuring tools is not the development of distinctly individual tools but the development of a family of integrated tools to optimize the restructuring process. Thus, a comprehensive review must be conducted to ensure that the desired integration of the various tools is achieved.

Once new or improved tools, or sets of tools, have been selected or created for application during MOS restructuring, the common features requirements must be examined both between and among the various methods. The features include:

- Modularity;
- Useful formatting of results;
- Validity;
- Flexibility; and
- Complete audit trail development.

These requirements have been defined previously in this paper and address the macro level analytical requirements of MOS restructuring. A review of these requirements should be conducted as part of a comprehensive systems engineering analysis of the MOS restructuring process. This review would include all newly developed tools as mechanisms for the performance of the various functional steps (transformation activities).

Future Efforts

This document provides an overall framework of the analytical requirements associated with tools and methods for MOS restructuring. The identification of these requirements lays a foundation for ARI to determine future research objectives with regard to analytical tools for MOS restructuring.

Although useful in this initial form, the present MOS Restructuring Research and Development Blueprint is incomplete. Further development is required both in terms of the identified analytical requirements and the data resources required in MOS restructuring.

Ultimately, when fully developed, each analytical method and data resource requirement identified in the blueprint should be described with respect to its function, logical structure, research requirement, technical approach, and additional related information needed for development. This original document does not achieve this level of detail. The completion of the MOS Restructuring Research and Development Blueprint will involve the following tasks:

1. Determine Existing Data Resources

   Relevant existing data resources will be identified and related to the analytical requirements that necessitate their use.

2. Develop Research Requirements for Data Resources

   Data resources that need to be developed in order to meet the restructuring analytical requirements will be identified.

3. Determine Blueprint Feasibility

   The operational and technical feasibility of the blueprint will be evaluated from a total systems perspective as well as in terms of each individual element.

4. Resolve Resource Requirements

   Project development and operating costs for each research element will be determined.

5. Appraise Potential Benefits

   The benefits of implementing the complete blueprint will be discussed as well as a detailed account of the benefits of each individual element.

6. Determine Research Priorities and Strategy

The priorities and optimum strategy for developing individual elements will be presented along with the rationale for both. A total analysis methodology and required data resources will also be discussed.

7. Develop Design Concepts for Analytical Methods and Data Bases

   The specific function, design concept, research specification, technical approach, and estimated effort for each restructuring requirement will be presented. These design concepts will be included in appendices to the blueprint.

Notwithstanding the need to address these additional issues, the work reported here provides a framework to complete and maintain the blueprint. The IDEFo depiction of the MOS restructuring functional architecture is a foundation upon which additional architectures related to data, systems, and procedures can be developed.

References

Akman, A. and Haught, D. (1990). Review and analysis of the military occupational speciality (MOS) restructuring problem. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0002, Research Note.

Bogner, M.S. (1988). Catalogue of MANPRINT methods. U.S. Army Research Institute.

Haught, D. and Akman, A. (1990a). Requirements-based restructuring of Army military occupational specialties. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0002, Research Note.

Haught, D. and Akman, A. (1990b). Prototype specifications for an automated position data analysis job aid. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0002, Working Paper.

Headquarters, Department of the Army. Force Integration. FM 100-11. Washington, D.C.: Headquarters, Department of the Army, 1988.

Kaplan, J. and Hartel, C. MANPRINT methods: Development of HARDMAN III. Alexandria, VA: U.S. Army Research Institute.

Marca, D. A., & McGowan, C. L. (1987). SADT - Structured Analysis and Design Techniques (ISBN 0-07-040-235-3). New York: McGraw-Hill.

Muckler, F.A., Seven, S.A., and Akman, A. (1990). Construction of military intelligence military occupational specialty taxonomy. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0001, Research Note.

Sorensen, H. (1988). Statement of work of the Specialty Structuring System S^3. Brooks Air Force Base, TX,: Development Manpower and Personnel Division, AFHRL.

Bibliography

BDM Services Company (1985). Army manpower cost system (AMCOS) economic and budget cost models (Final Report). Monterey, CA: BDM Services Company, Contract No. N00014-84-C-0712.

Boyle, E. (1989). SUMMA summary. (AFHRL-TP-89-XX). Wright-Patterson Air Force Base, OH: Logistics and Human Factors Division, Air Force Human Resources Laboratory.

Boyle, E. (1986). Small unit maintenance manpower analyses (Project SUMMA). Wright-Patterson Air Force Base, OH: Logistics and Human Factors Division, Air Force Human Resources Laboratory.

Carroll, R.J., Roth, J.T., Evans, D.C., and Ditzian, J.L. (1988). Implementing embedded training (ET): Volume 10 of 10: Integrating ET into acquisition documentation. (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Cherry, W.P., Peckham, D.S., Purifoy, G.R. Jr., and Roth, J.T. (1988). Implementing embedded training (ET): Volume 9 of 10: Logistics Implications. (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Christ, R.E., Conroy, J.A., and Briggs A. Systematic organizational design (SORD) methodology demonstration.

Evans, S.M. and Cherry, W.P. (1988). Implementing embedded training (ET): Volume 6 of 10: Integrating ET with the prime system. (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Finley, D.L. and Alderman, I.N. (1988). Implementing embedded training (ET): Volume 1 of 10: Overview. (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Haught, D. and Enwright, J. (1990). Battlefield maintenance case study: Task commonality analysis for system maintenance requirements. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0003, Research Product.

Headquarters, Department of the Army. Basis of Issue Plans and Quantitative and Qualitative Personnel Requirements Information. Army Regulation 71-2. Washington, D.C.: Headquarters, Department of the Army, 1983.

Headquarters, Department of the Army. Commissioned Officer Classification System. Army Regulation 611-101. Washington, D.C.: Headquarters, Department of the Army, 1989.

Headquarters, Department of the Army. Enlisted Career Management Fields and Military Occupational Specialties. Army Regulation 611-201. Washington, D.C.: Headquarters, Department of the Army. 1989.

Headquarters, Department of the Army. Guide for Preparation of Changes to the Military Occupational Classification Structure (MOCS). Washington, D.C.: Headquarters, Department of the Army, 1988.

Headquarters, Department of the Army. Manual of Warrant Officer Occupational Specialties. Army Regulation 611-112. Washington, D.C.: Headquarters, Department of the Army, 1989.

Headquarters, Department of the Army. Military Occupational Classification Structure and Implementation. Army Regulation 611-1. Washington, D.C.: Headquarters, Department of the Army, 1989.

Headquarters, Department of the Army. The Life Cycle Management Model for Army Systems. Department of the Army Pamphlet 11-25. Washington, D.C.: Headquarters, Department of the Army, 1987.

Headquarters, Department of the Army. The Personnel Proponent System. Army Regulation 600-3. Washington, D.C.: Headquarters, Department of the Army, 1987.

Headquarters Training and Doctrine Command (TRADOC). TRADOC PAM 350-4, Army Training 2007 (Final Draft, 27 April 1990). Headquarters Training and Doctrine Command.

Link Training Services Division. HITT Training Methodology. Alexandria, VA: CAE - Link Corporation, Contract No. OPM-87-9002/W.O. 8002-029.

Herlihy, D.H., Iceton, J.A., Oneal, J., and Guptill, R.V. (1985). Man integrated systems technology (User's Guide). Wilimington, MA: Dynamics Research Corporation.

Lowry, J.C. and Seaver, D.A. (1988). Handbook for quantitative analysis of MANPRINT considerations in Army systems. (ARI Research Product 88-15). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Muckler, F.A., Seven, S.A., Akman, A., Knapp, B.G., and Burnstein, D. (1990). Development and application of military intelligence (MI) job comparison and analysis tool

(JCAT). Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0001, Technical Report.

Muckler, F.A., Seven, S.A., and Akman, A. (1990). Proposed method for military intelligence job ability assessment. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0001, Research Note.

Purifoy, G.R. Jr., Ditzian, J.L., and Finley, D.L. (1988). Implementing embedded training (ET): Volume 7 of 10: ET Test and evaluation. (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Rossmeissl, P., Akman, A., Kerchner, R., Faucheux, G., Wright, E., Shields, J., and Waldrop, G. Analysis of manpower personnel, training, and safety during the acquisition of Air Force systems: Requirements and capabilities. Volume I, Executive Summary.

Roth, J.T. (1988). Implementing embedded training (ET): Volume 3 of 10: The roles of ET in the training system concept. (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Roth, J.T. (1988). Implementing embedded training (ET): Volume 4 of 10: Implementing ET requirements (REVISED). (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Roth, J.T., Fitzpatrick, J.A. Warm, R.E., and Ditzian, J.L. (1988). Implementing embedded training (ET) Volume 5 of 10: Designing the ET component (REVISED). (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Shipman, M.G. and Finley, D.L. (1989). Military occupational specialty (MOS) restructuring: An annotated bibliography. (ARI Research Note). Alexandria, VA: Army Research Institute for the Behavioral and Social Sciences.

Steinbach, C. and Akman, A. (1990). Developing an equipment domain model for use in MOS restructuring. Silver Spring, MD: Akman Associates, Inc., Contract No. DAHC35-89-D-0028 0002.

Strasel, H.C., Dyer, F.N., Roth, J.T., Alderman, I.N., and Finley, D.L. (1988). Implementing embedded training (ET): Volume 2 of 10: Embedded training as a system alternative (REVISED). (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Strasel, H.C., Strasel, B., Aldrich, R., and Roth, J.T. (1988). Implementing embedded training (ET): Volume 8 of 10: Incorporating ET into unit training. (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army Soldier Support Center (1987). Early comparability analysis (ECA) procedural guide.

Acronyms

AFS	Air Force Specialty
AIM	AFS Impact Model
AIT	Advanced Individual Training
AMC	Army Materiel Command
AMCOS	Army Manpower Cost System
AR	Army Regulation
ARI	Army Research Institute
ASIs	Additional Skill Identifiers
ASVAB	Armed Services Vocational Aptitude Battery
BMS	Battlefield Maintenance System
BOIP	Basis of Issue Plan
BOIPFD . . .	BOIP Feeder Document
CAD	Course Administrative Data
CAT	Categories
CBRS	Concept Based Requirements System
CBRS	Concept Based Requirements System
CMFs	Career Management Fields
CRM	Cognitive Requirements Model
DCSLOG . . .	Deputy Chief of Staff, Logistics
DCSPER . . .	Deputy Chief of Staff, Personnel
DES	Design Evaluation Subsystem
ECA	Early Comparability Analysis
ET	Embedded Training
HFEA	Human Factors Engineering Analysis
IDEFo	Information Definition, Mod 0
IET	Initial Entry Training
ITP	Individual Training Program
JAAS	Job Abilities Assessment System
JOIN	Joint Optical Information Network
KAs	Knowledge, Skills, and Abilities
LCSMM	Life Cycle System Management Model
LCOM	Logistics Composite Model
M-CON	Manpower Constraints Aid

MACOM	Major Army Commands
MAN-SEVAL . .	Manpower-Based System Evaluation Aid
MANCAP II . .	Manpower Capabilities II
MANPRINT . .	Manpower and Personnel Integration
MARC	Manpower Requirements Criteria
MEPSCAT . . .	Military Enlistment Physical Strength Capacity Test
MFS	Mission to Function Subsystem
MIST	Man-Integrated Systems Technology
MOCS	Military Occupational Classification Structure
MOSs	Military Occupational Specialties
MPT	Manpower, Personnel, and Training
MRD	Manpower Requirements Determination Model
MSA	MOS Selection Aid
ODCSOPS . . .	Office of the Deputy Chief of Staff for Operations and Plans
ODCSPER . . .	Deputy Chief of Staff for Personnel
P-CON	Personnel Constraints Aid
PC	Personnel Computer
PDAT-JA . . .	Position Data Analysis Job Aid
PER-SEVAL . .	Personnel-Based System Evaluation Aid
POI	Program of Instruction
PRD	Personnel Requirements Determination Model
QQPRI	Qualitative and Quantitative Personnel Requirements Information
RAM	reliability, availability and maintainability
S^3	Specialty Structuring System
SAT	Systems Approach to Training
SGA	Standards of Grade Authorization
SIMOS	Space Imbalanced MOS
SORD	Systematic Organizational Design
SPARC	System Performance and RAM Criteria Aid
SQIs	Specialty Qualification Identifiers
SUMMA	Small Unit Maintenance Manpower Analysis
STRAP	System Training Plan

T-CON	Training Constraints Aid
TAADS	The Army Authorizations Documents System
TAD	Target Audience Description
TCAM	Task Commonality Analysis Model
TCR	Training Costs and Resources Determination Model
TMS	Training Media Selection Model
TOE	Tables of Organization and Equipment
TRADOC . . .	Training and Doctrine Command
TTHS	Trainees, Transients, Holdees, and Students
UDS	Unit Design Subsystem
URS	Unit Reference Sheet
USAFICA . . .	U.S. Army Force Integration Command Agency
USAPIC . . .	U.S. Army Personnel Integration Command

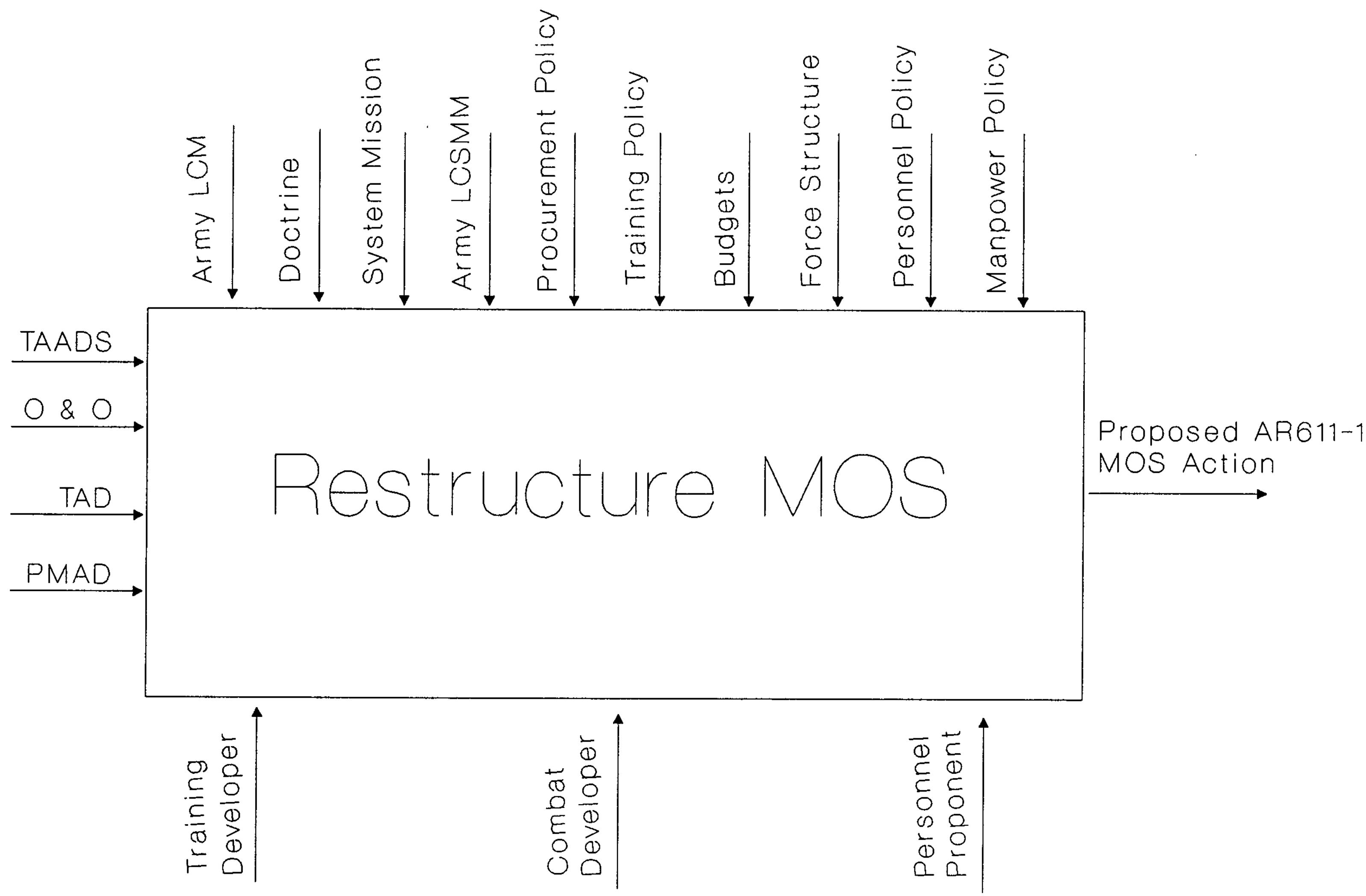
Appendix A. IDEFo Diagrams Depicting the MOS Restructuring Functional Architecture

Appendix A

Table of Contents

A-0 Restructure MOS

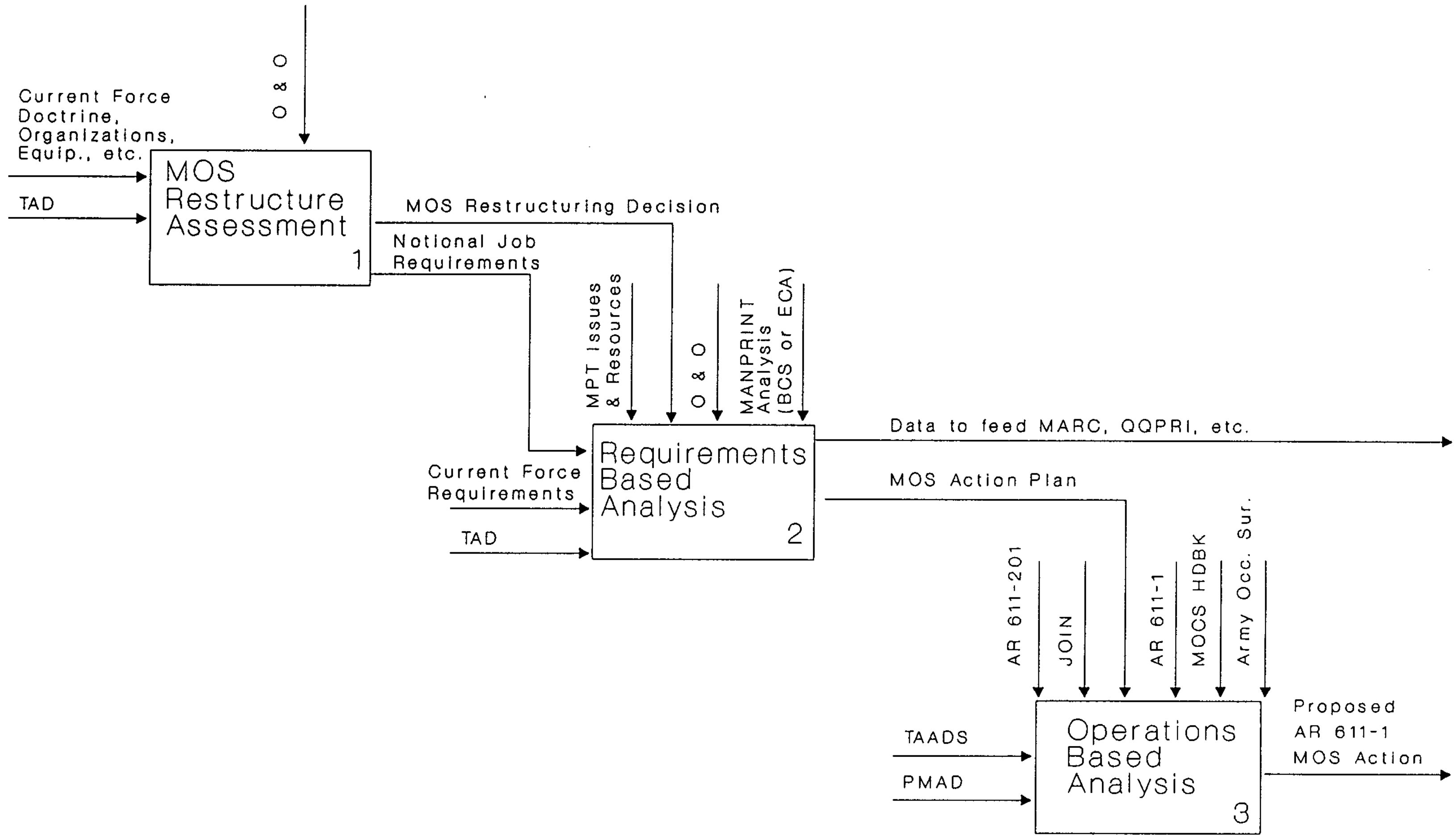
This is the top-level IDEFo diagram for the MOS restructuring process. From this diagram the hierarchical functional architecture emanates. The diagram defines the interfaces which influence the entire restructuring process. The goal of the restructuring process is to produce a well researched and integrated MOS action in support of a proposed change.



A-0 - The MOS Restructuring Process

A0 Restructure MOS

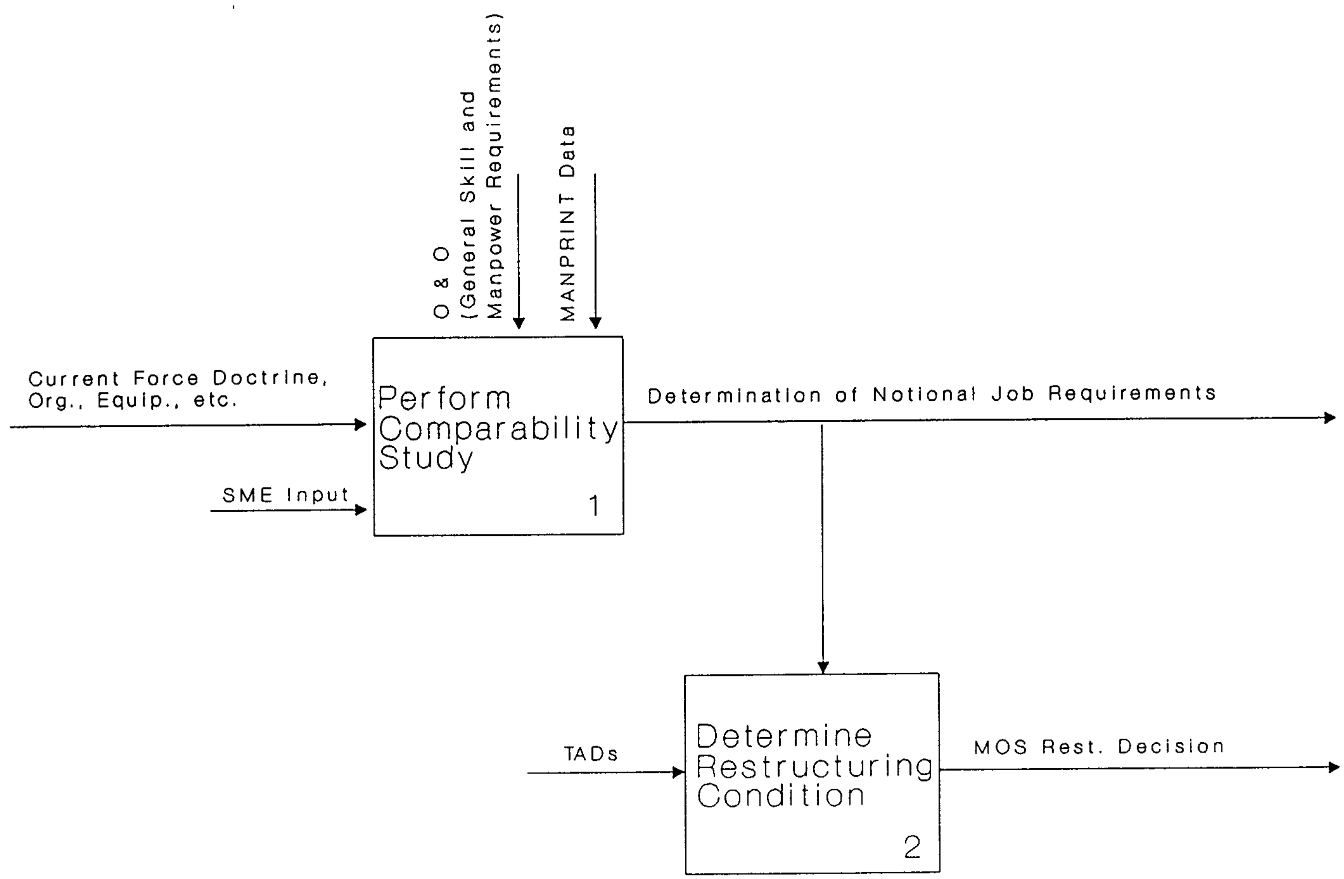
As depicted in the diagram, the MOS restructuring process is composed of three distinct efforts from which the impact of a change is evaluated regarding MOS requirements. Each step in the process has a pre-defined objective, and all steps should be completed prior to making a final MOS decision.



A0 - Restructure MOS

A01 MOS Restructure Assessment

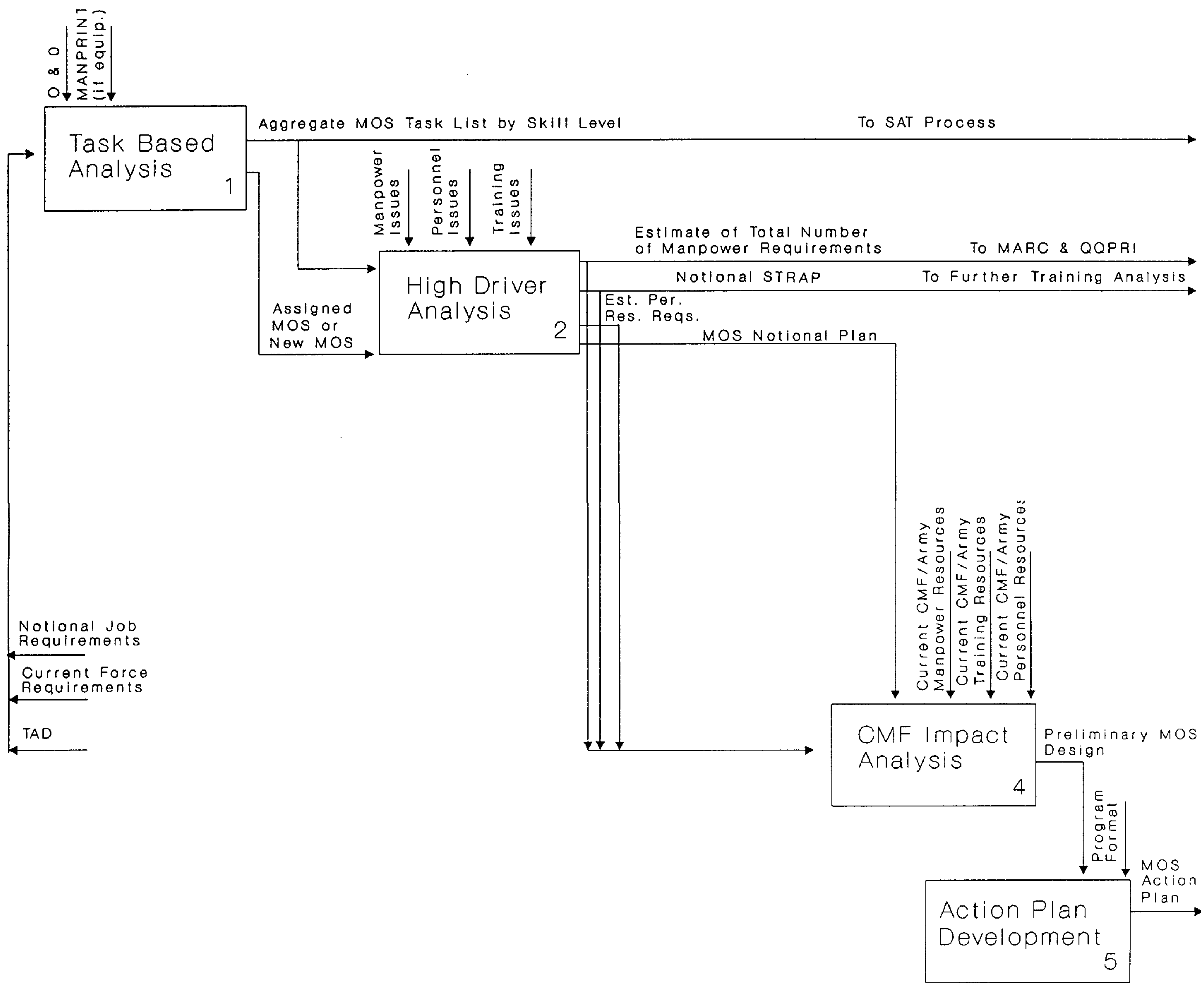
This diagram describes the initial activities involved in determining the probability of a future MOS restructuring action. The O&O plan is first examined to obtain the general skill and manpower requirements of the proposed change. This information is then evaluated against current force data obtained from sources such as: (1) doctrine and doctrinal literature, (2) sections one, two, and three of current and proposed tables of organizations and equipment (TOEs), (3) input from subject matter experts, and (4) MANPRINT data if the change is equipment driven. This comparability study allows the determination of the general job requirements of soldiers needed to support the change. These job requirements are then compared with the job requirements of existing Army MOSs, and an initial decision is made regarding the need for restructuring or creating a new MOS.



A01 - MOS Restructure Assessment

A02 Requirements-based Analysis

This diagram depicts the four major steps of Requirements-based Analysis. These steps explore alternatives in the development of a notional MOS concept, or action plan. The combat developer assumes overall responsibility for this activity that examines the feasibility of restructuring MOSs within his domain in order to support changes in doctrine, organizations, and equipment. This effort is supported by the training developer and the personnel proponent.

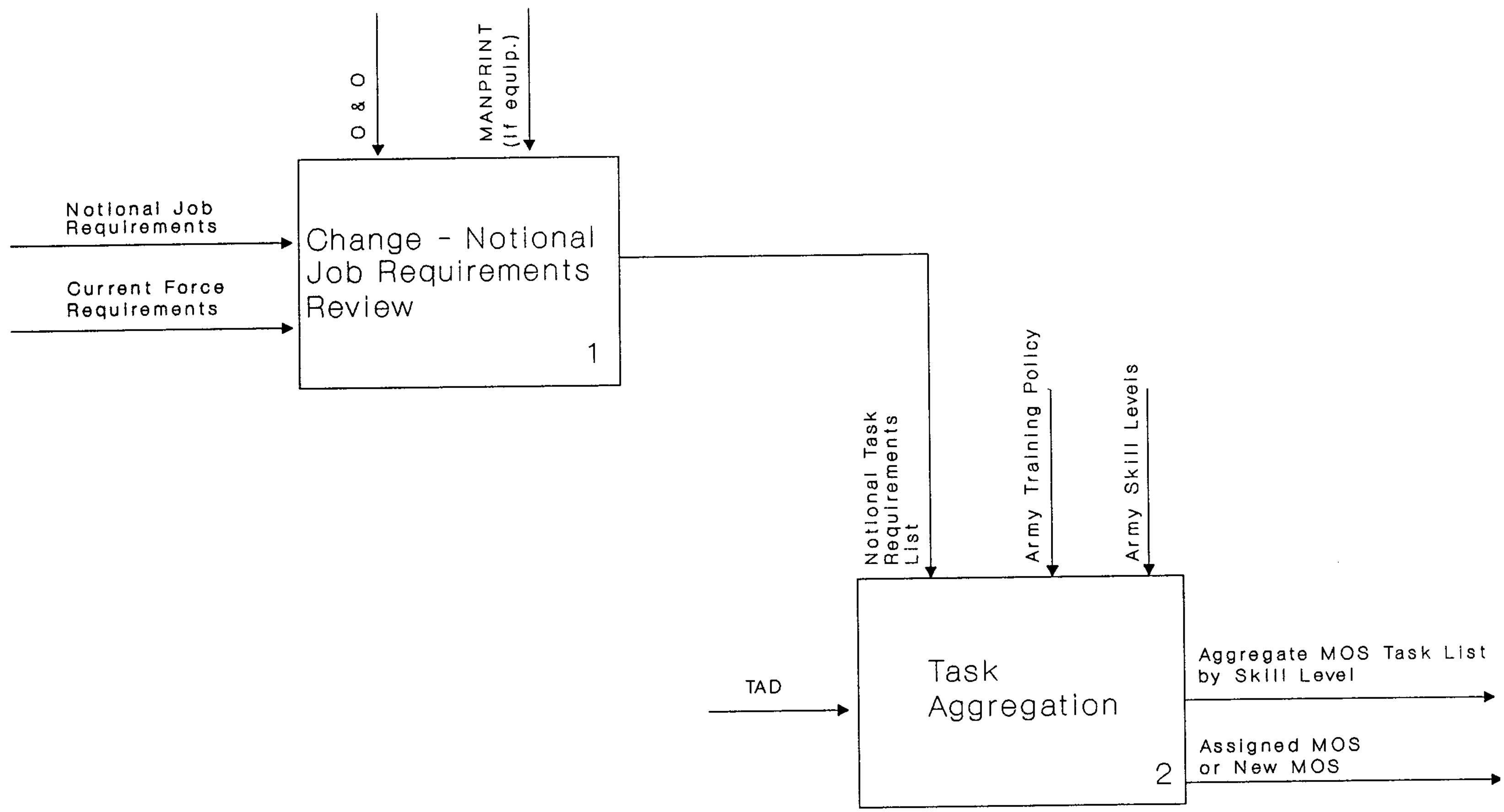


A02 - Requirements-based Analysis

A021 Task-based Analysis

This activity focuses on the development of occupational requirements based on projected task demands. These data allow alternative MOS restructuring concepts or strategies to be evaluated. During this analysis step notional job requirements, current force requirements, and MOS target audience descriptions are evaluated against the soldier constraints described in the O&O plan, MANPRINT information (if equipment driven), and regulatory guidance. The outputs from this activity are an aggregate MOS task list by skill level, and the assignment of an MOS to perform these tasks. MOS assignment may be a current, revised or new MOS.

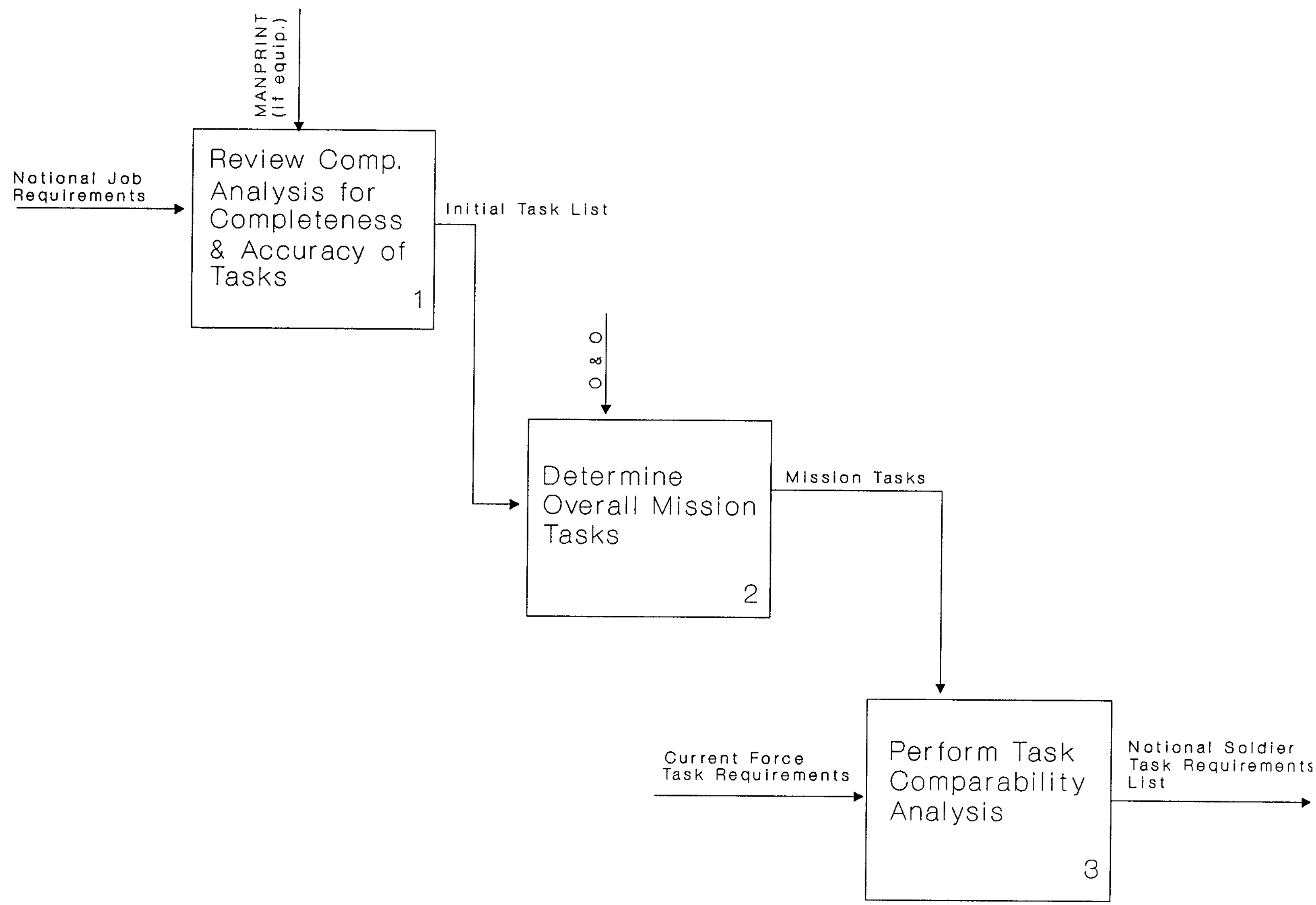
The combat developer and the training developer are involved in this analysis step. The combat developer provides guidance and (1) reviews the notional job requirements, (2) delineates current force requirements, (3) defines the O&O and MANPRINT constraints, and (4) provides input on the MOS decision. The training developer (1) performs the notional job requirements review, (2) develops the notional tasks requirements list, (3) makes inputs regarding the MOS decision, and (4) aggregates the MOS tasks by skill level.



A021 - Task-based Analysis

A0211 Change-Notional Job Requirements Review

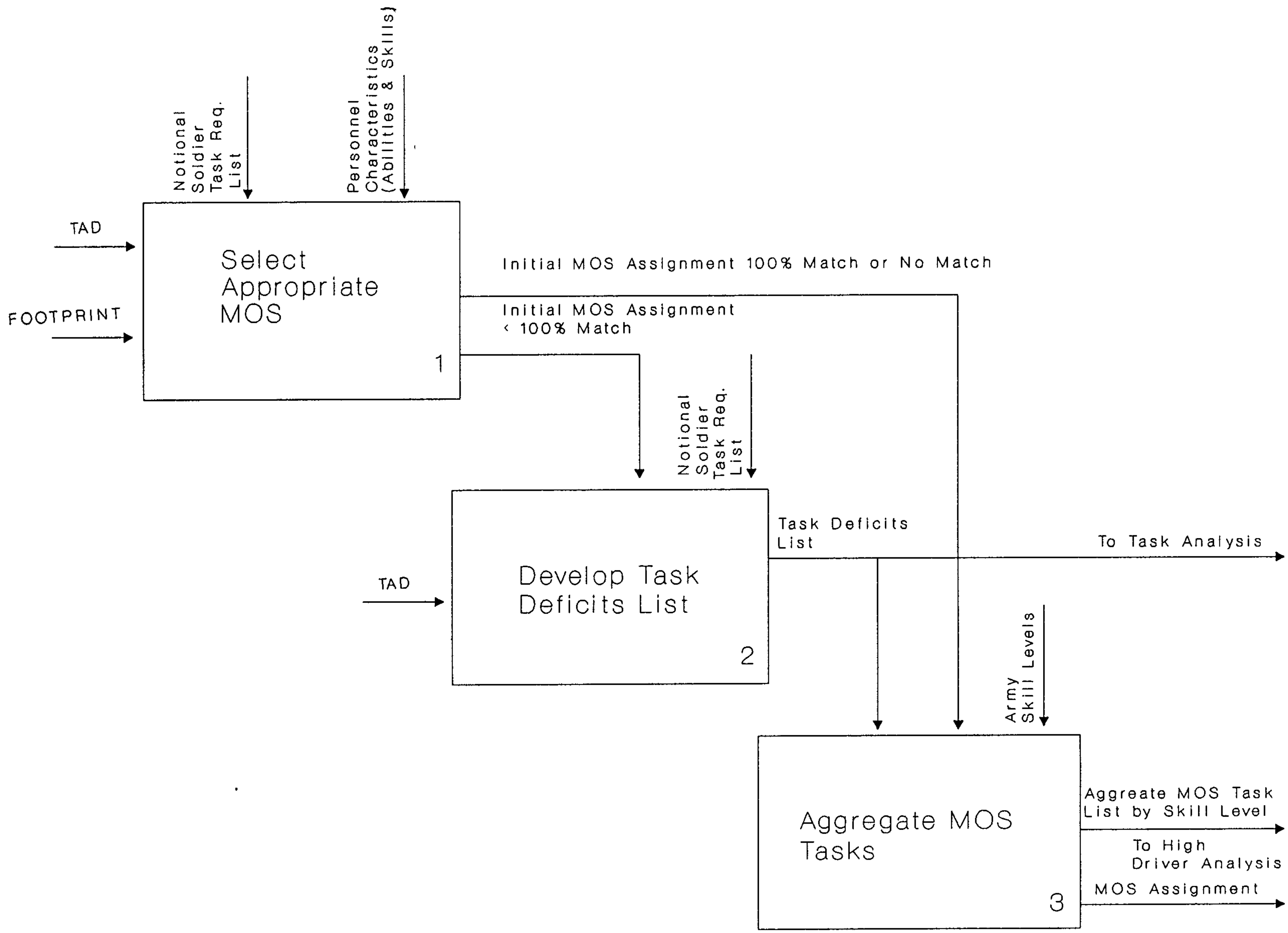
The job requirements review is performed to identify and assess the characteristics of the job requirements driven by the change. A review is first conducted of the comparability analysis preformed during the MOS Restructure Assessment. The assessment is reviewed for completeness and accuracy, and an initial task list is constructed. This list is then evaluated in terms of the overall mission tasks stated in the O&O to determine specific mission task requirements. These task lists are then compared with those task requirements existing in the current force. A notional task requirements list is prepared to feed the next step of the Task-based Analysis.



A0211 - Change-Notional Job Requirements Review

A0212 Task Aggregation

Working from the notional task requirements list, the TADs and personnel characteristics of existing MOSs are evaluated to determine if an MOS assignment can be made within the domain of existing MOSs. If an exact match is obtained, the TAD of the selected MOS is re-aggregated and directed to the next analysis step. This immediate aggregation of tasks also occurs if no MOS is identified and a new MOS is created. However, if less than an exact match is found, a tasks deficits list must be developed. This activity involves the identification of tasks which are part of the notional task list, but not accounted for in the existing TAD. Tasks which are not part of the existing TAD are then aggregated with existing tasks so that all tasks identified for the assigned MOS are considered. All tasks are aggregated by skill level.



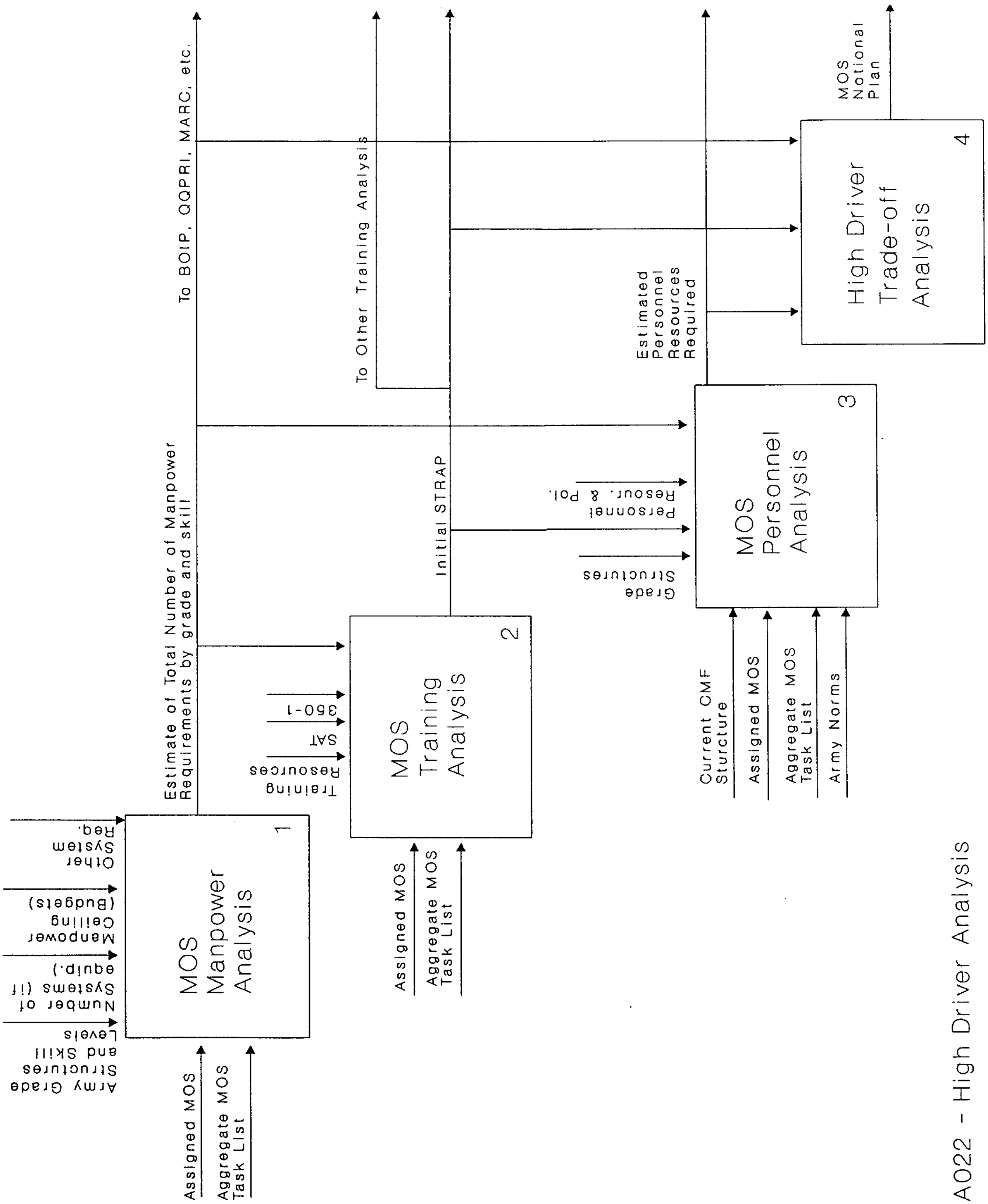
A0212 - Task Aggregation

A022 High Driver Analysis

High Driver Analysis is performed to assess the impact of manpower, training, and personnel on the MOS decision. This analytical step is imperative to the successful integration of new or revised MOS into the Army's force structure. Considerable emphasis is placed on this activity during the requirements-based process.

During this phase of analysis, the combat developer, training developer, and the personnel proponent are involved in the performance of the analytical steps. The combat developer performs manpower analysis, provides guidance and develops data to support the other analytical steps of the process. The training developer performs MOS Training Analysis and develops the STRAP which supports MOS Personnel Analysis. The STRAP provides an outline of how the new or revised MOS will be trained and the training resources required. The personnel proponent performs MOS personnel analysis to estimate the personnel resources required to support the change. Taken together, the outputs from these analyses serve as the baseline for a new or revised MOS and informed trade-offs.

As the MOS solutions evolve, the trade-offs between the projected and current MPT resources must be repeatedly examined. Thus, trade-off analyses are performed systematically throughout all high driver analytical steps. The location of the trade-off analysis step within the High Driver Analysis process reflects the cumulative effect of all trade-off assessments made throughout these steps, rather than a single comprehensive trade-off analysis. The MPT solutions developed through High Driver Analysis are fully developed through the trade-off process. The product of these systematic trade-offs is a MOS Notional Plan.

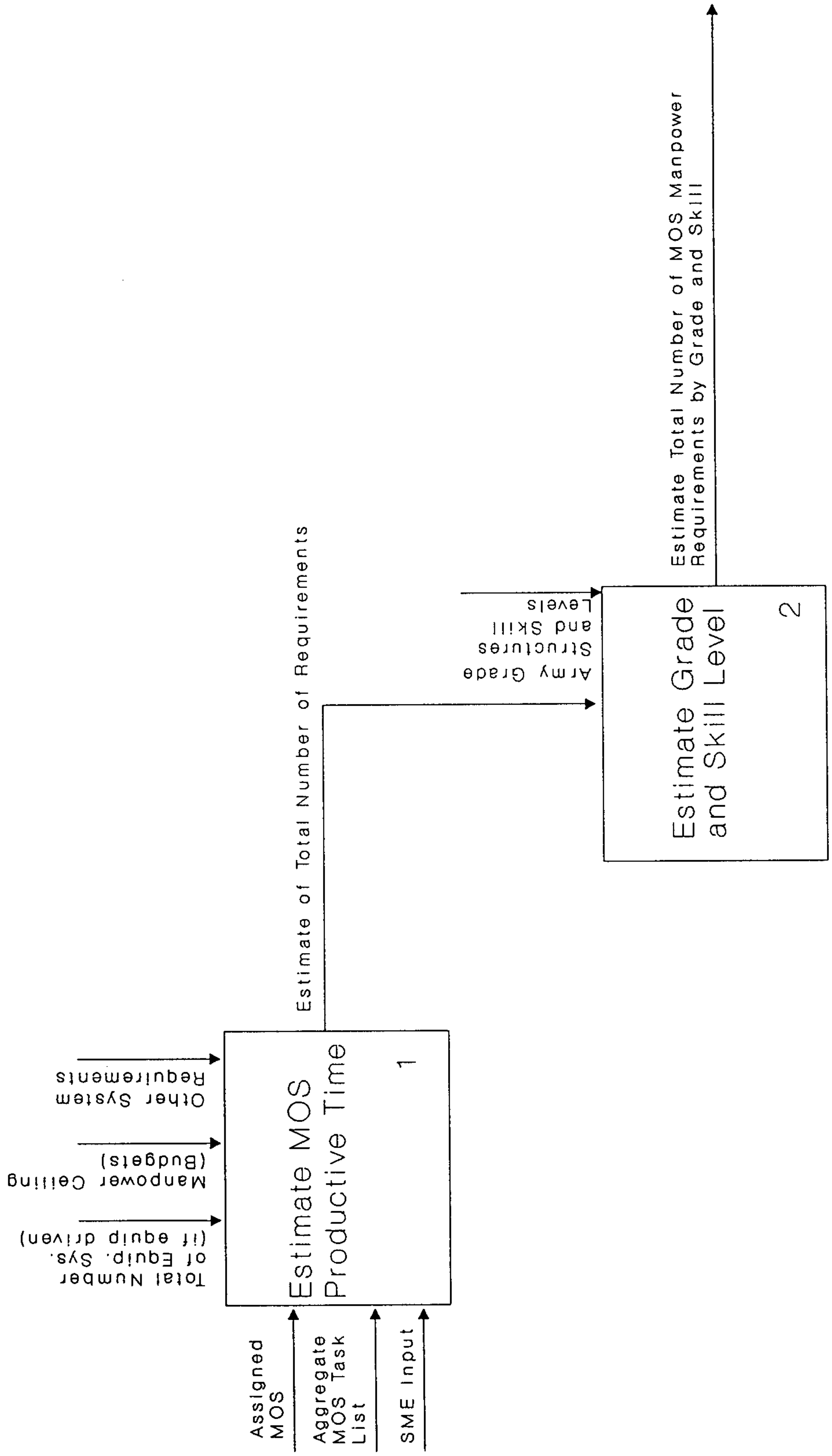


A022 - High Driver Analysis

A0221 MOS Manpower Analysis

MOS Manpower Analysis provides the framework from which to determine the number and skill level of MOS positions needed to support the change. The activity begins by estimating the productive time required of the MOS in the performance of assigned MOS tasks. Based on this data, a further estimation of the total number MOS manpower requirements can be made.

Once the total manpower requirements are determined, the MOS tasks and manpower requirements are then further analyzed to assess how workload should be distributed between skill levels. The output from MOS Manpower Analysis provides the initial skill level breakout and the basis for performing MOS Training and Personnel Analysis.

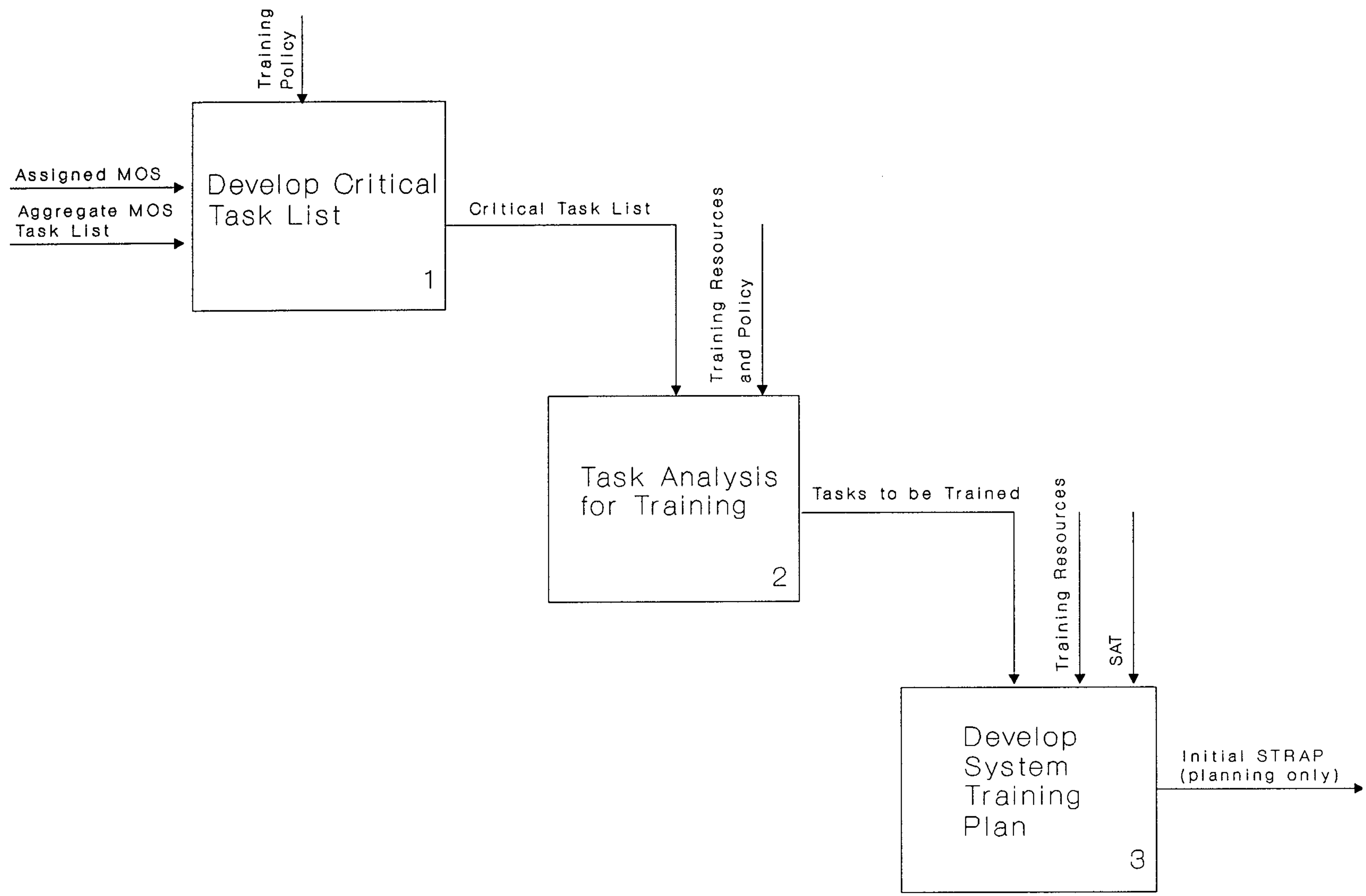


A0221 - MOS Manpower Analysis

A0222 MOS Training Analysis

The goal of MOS Training Analysis is to create an initial individual and collective training plan to support the training portion of integrating a new or revised MOS into the Army's force structure. This analytical process contains three major elements (1) development of an initial critical tasks list, (2) provisional selection of tasks to be trained, and (3) development of a notional STRAP. The STRAP provides an outline of both collective and individual tasks to be trained, how they will be trained, and the training resources required to support the training.

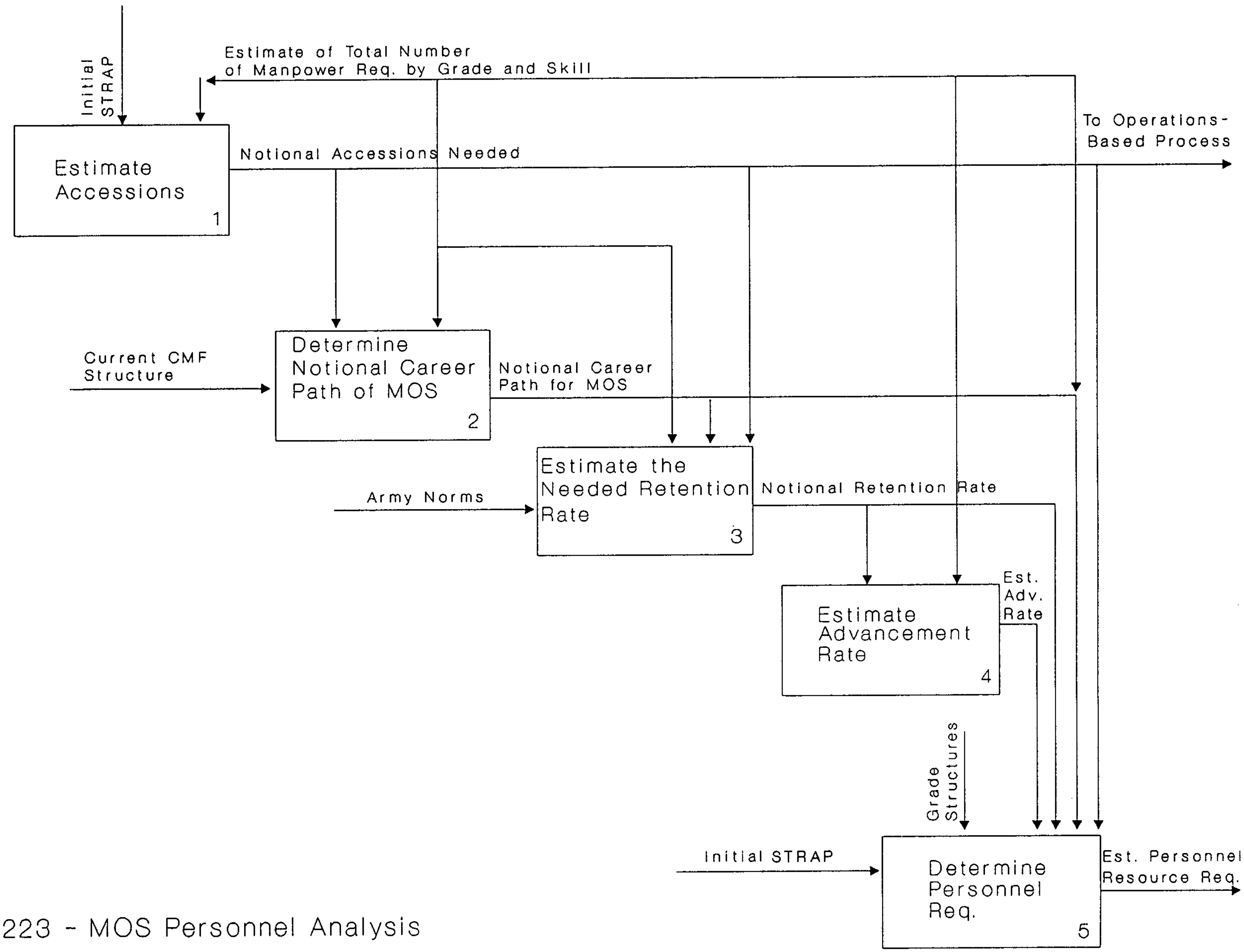
Restructuring training analysis does not replace SAT. The MOS Training Analysis described here provides initial training strategies that are expanded and refined through the SAT process.



A0222 - MOS Training Analysis

A0223 MOS Personnel Analysis

The purpose of MOS Personnel Analysis is to estimate the personnel resources required in order to support the change. The steps that comprise this activity will enable the personnel proponent; and by extension the combat developer to make determinations regarding the supportability of the manpower and training decisions made in the previous two analysis steps. The outputs from MOS Personnel Analysis include notional accession requirements, MOS career paths, retention rates, advancement rate estimates, and personnel resource requirements. This level of personnel analysis is designed to support the optimization of manpower and training decisions that are made based upon information developed through previous analysis steps. This level of analysis does not, however, provide the level of detail needed to fully integrate the MOS into the force structure. Further analysis steps will be required to support this function.



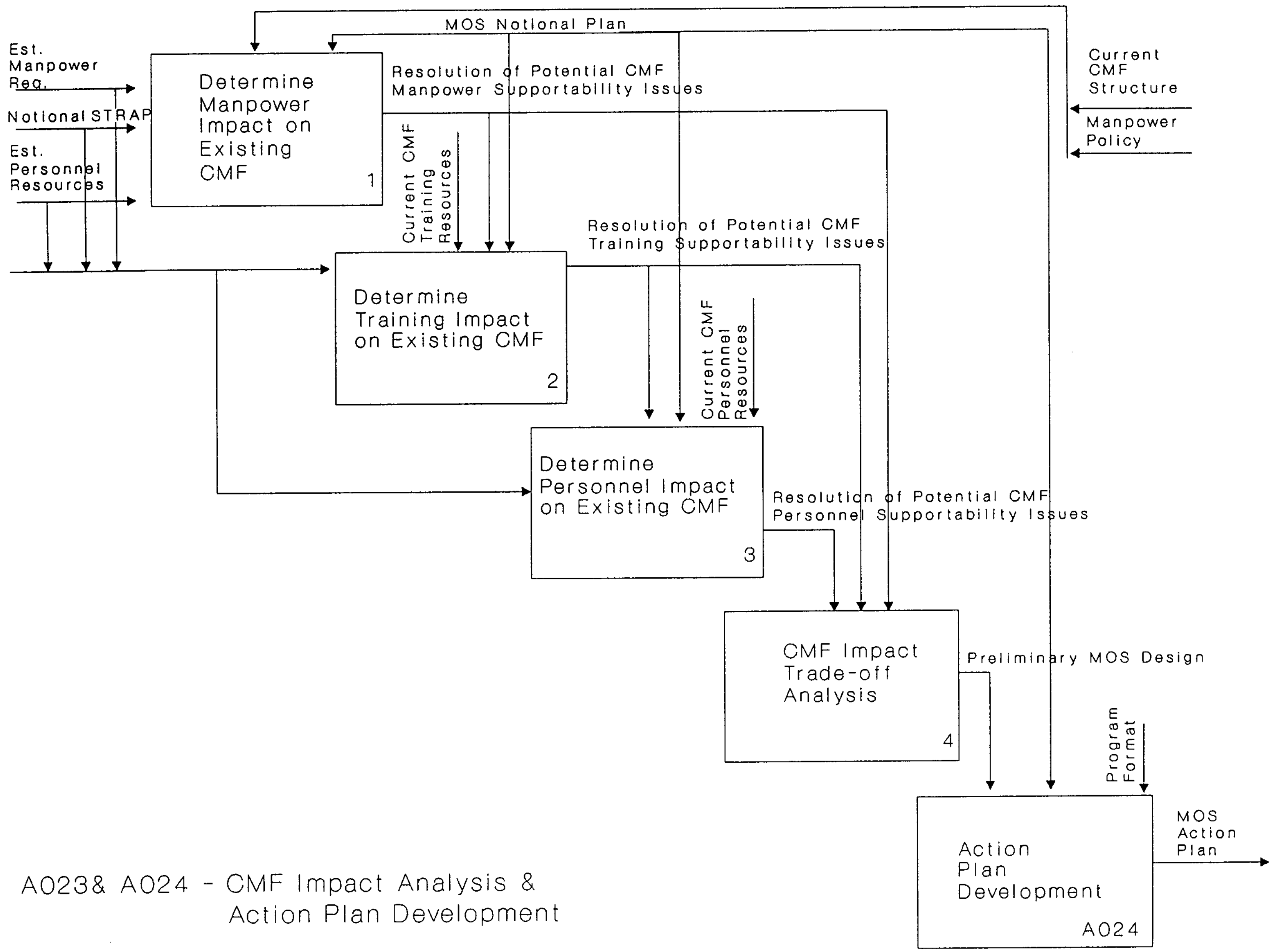
A0223 - MOS Personnel Analysis

A023 & A024 CMF Impact Analysis & Action Plan Development

The CMF Impact Analysis steps are designed to support the macro level assessments necessary for optimizing the integration of the new or modified MOS into the Army's force structure. The activity utilizes the outcomes of all previous analytical steps described in the MOS notional plan. A systematic evaluation of those issues that effect the introduction of either a revised MOS or new MOS into a CMF are examined through the analysis.

The CMF Impact Trade-off Analysis addresses the evaluation that occurs throughout CMF Impact Analysis whereby appropriate CMF level trade-offs are made systematically. The MOS notional Plan and various outputs from the CMF Impact Analysis provide constraints and inputs to the trade-off process.

The data generated through CMF Impact Analysis are then compiled to produce a Preliminary MOS Design. The Preliminary MOS Design and MPT resource requirements detailed in the MOS Notional Plan are then documented in an MOS Action Plan. The MOS Action Plan is developed for the personnel proponent to use as an MOS blueprint during operations-based MOS restructuring.

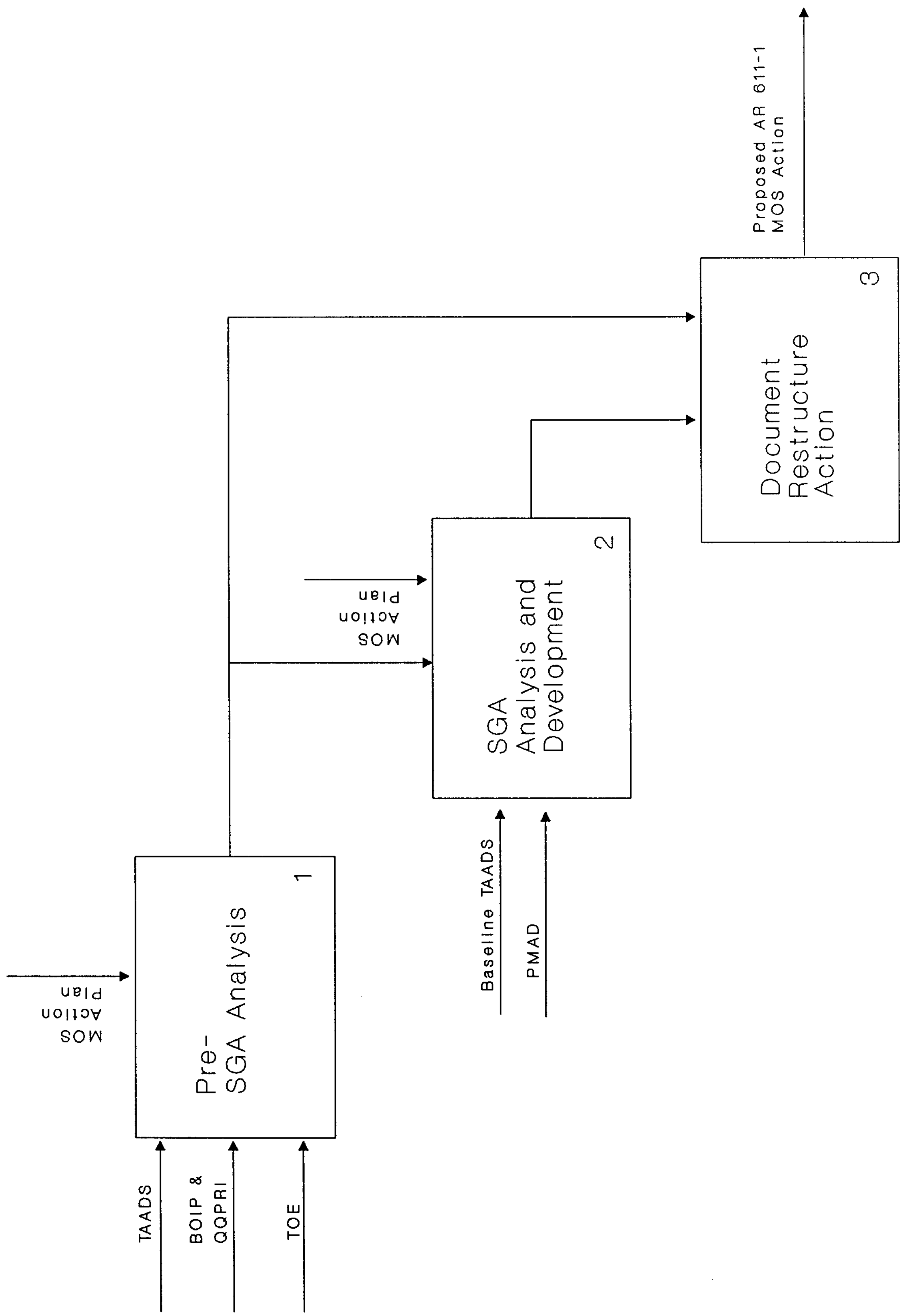


A023& A024 - CMF Impact Analysis & Action Plan Development

A03 Operations-based Restructuring

Operations-based MOS restructuring consists of three major analytical processes. The first of these analytical processes is Pre-SGA Analysis. Next is SGA Analysis and Development, followed by the documentation of the restructuring action.

The main goal of operations-based restructuring is to develop and document the required personnel system to support the introduction of change. The analytical steps performed in the operations-based process culminate in the development of a Proposed AR 611-1 MOS Action. This recommendation provides guidance for Headquarters Department of the Army to use in accessing, training, distributing, developing, and sustaining the personnel force resulting from new force requirements.

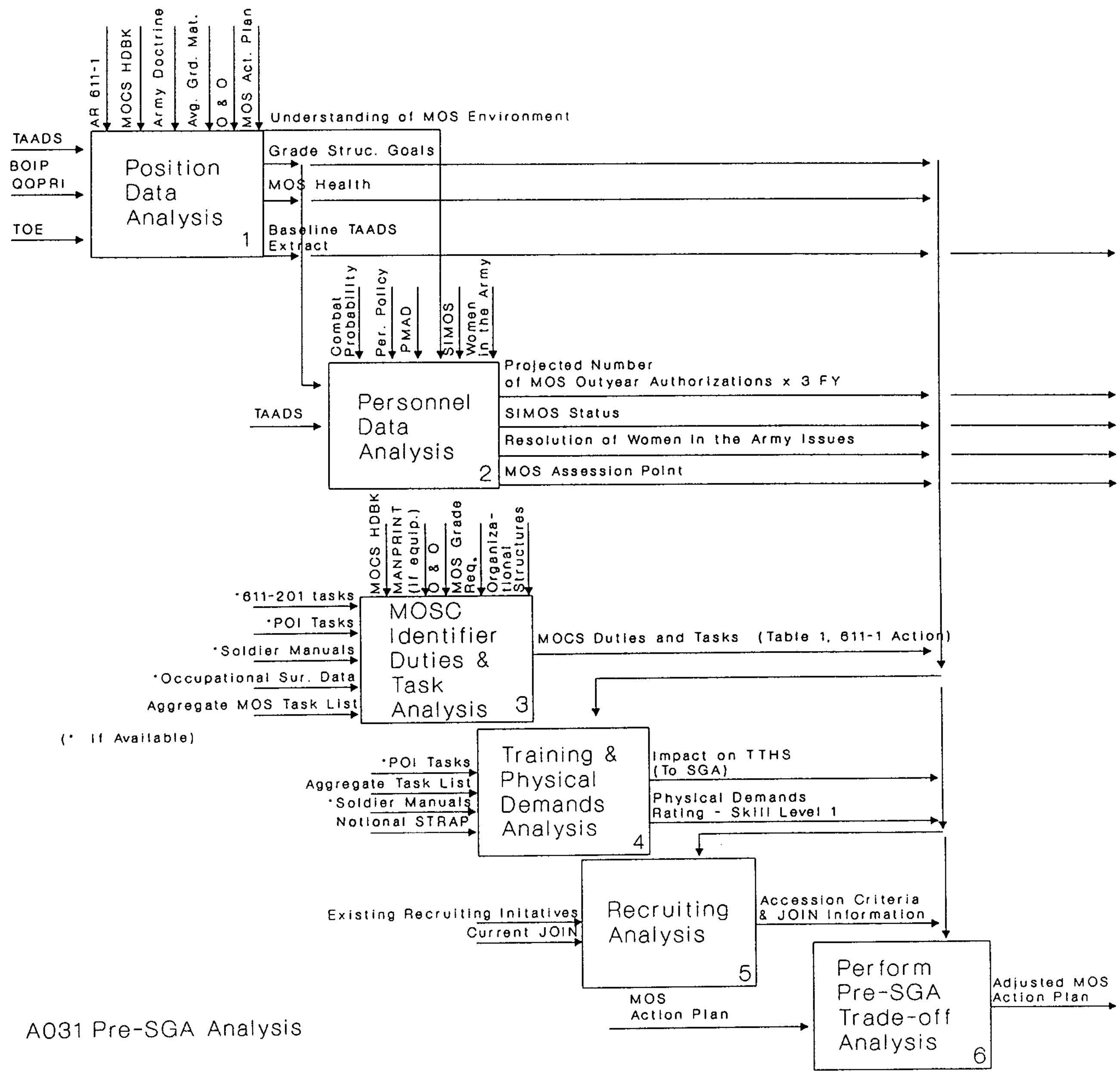


A03 Operations-based Restructuring

A031 Pre-SGA Analysis

These activities are conducted to develop data that feed and drive the development of a personnel support system to meet the restructuring requirements of the change. This activity is constrained by existing resources and is formulated in accordance with AR 611-1. AR 611-1 serves as the major policy governing the establishment and maintenance of MOSs and CMFs.

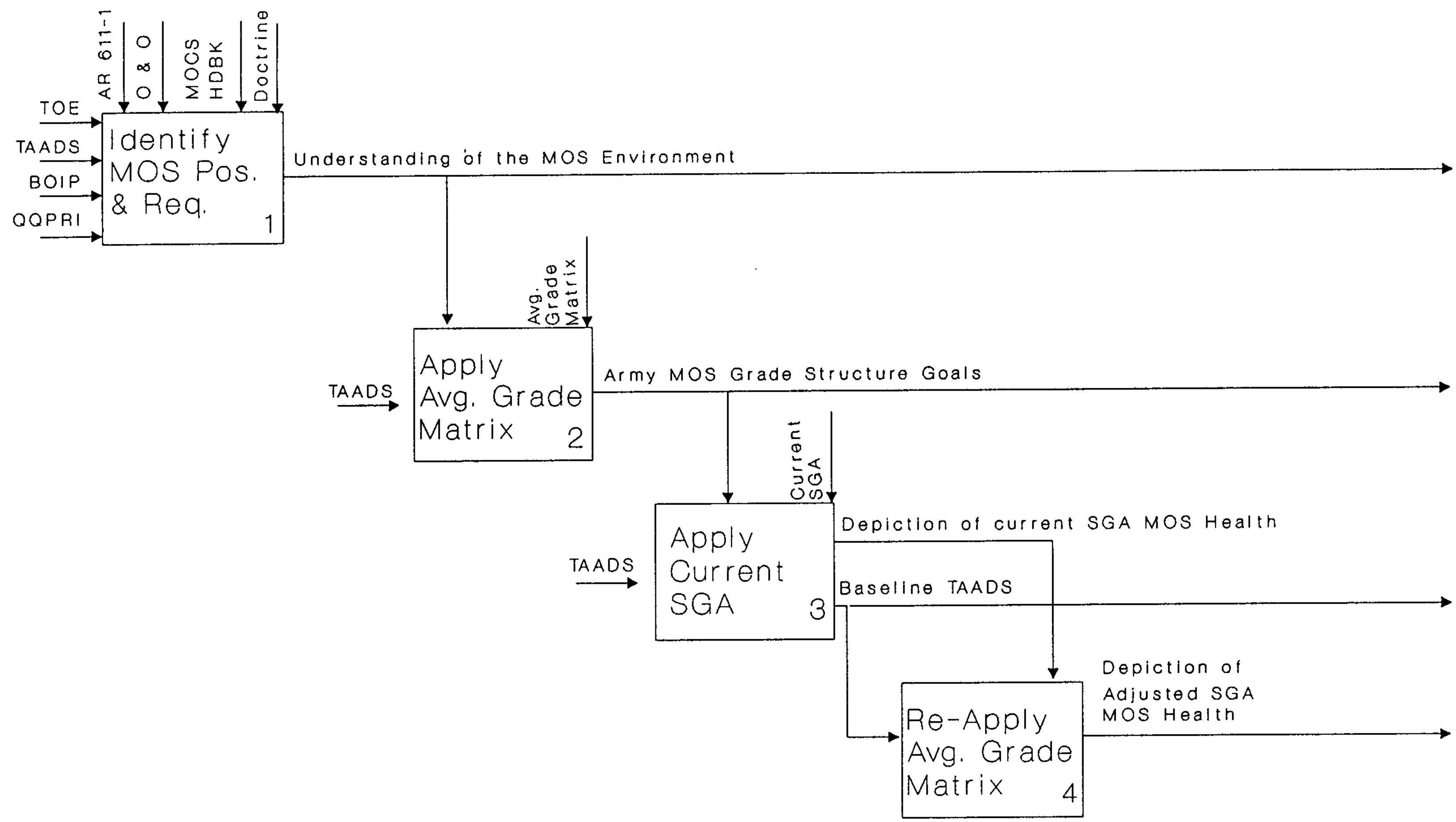
The trade-off analysis depicted represents a systematic evaluation of trade-offs between Personnel Data, Position Data, MOCS Identifier Duties and Tasks, Training, Physical Demands, and Recruiting Analyses. These trade-offs are made throughout Pre-SGA Analysis and ensure that the Adjusted MOS Action Plan is a balanced, realistic, affordable approach prior to use in SGA Analysis and Development.



A031 Pre-SGA Analysis

A0311 Position Data Analysis

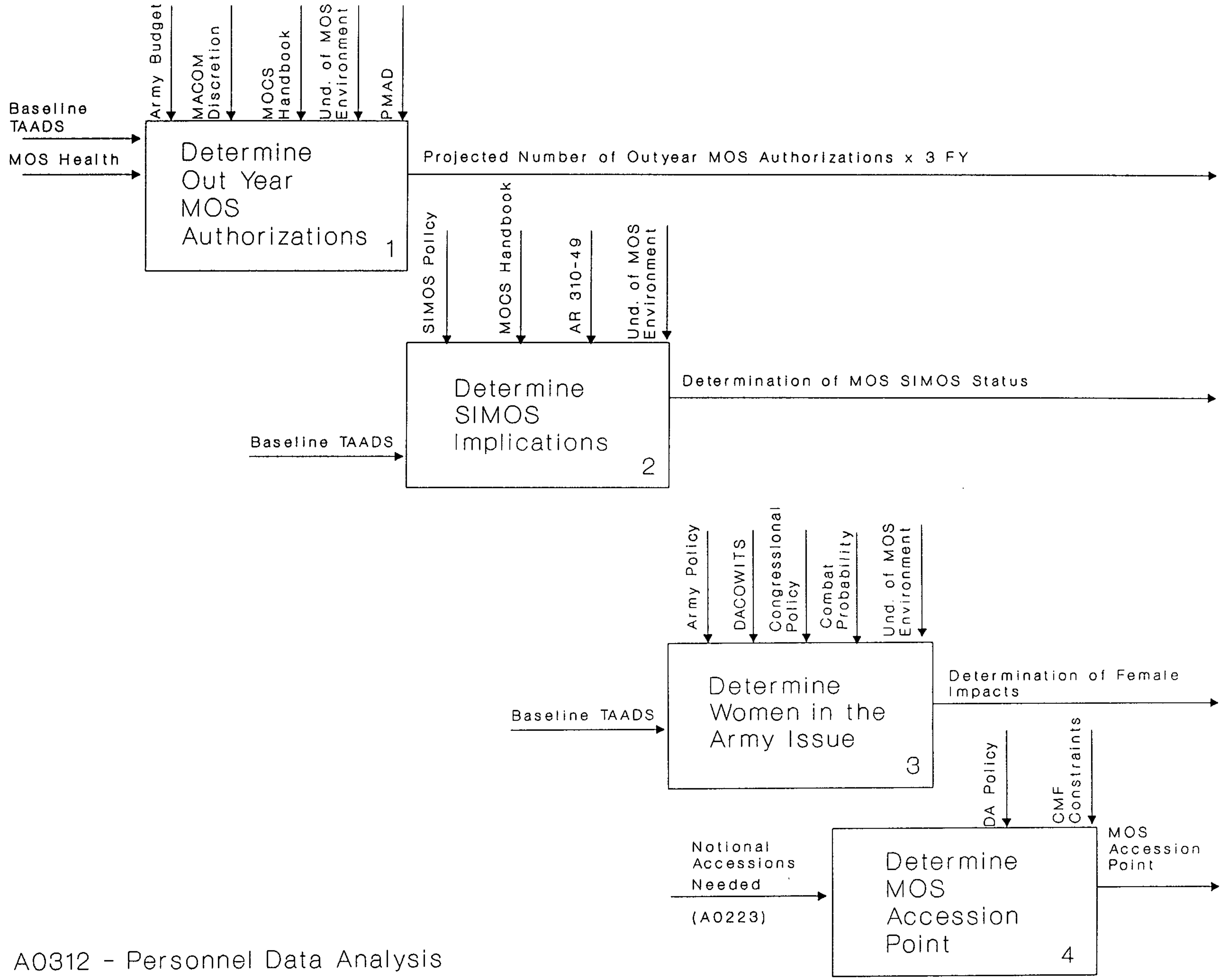
The goal of Position Data Analysis is to provide the analyst with an overview of (1) the relative health of the MOS, (2) types and numbers of organizations in which the MOS is projected or found, (3) the geographic locations and parent organizations (battalion, brigade, division, etc.) where the MOS is or will be authorized, and (4) the total number of positions and grade structure needs of the MOS. This analytical step provides several related outputs that feed the continuation of operations-based analysis. These outputs allow a composite picture of the new or revised MOS to be drawn for further analysis steps.



A0311 - Position Data Analysis

A0312 Personnel Data Analysis

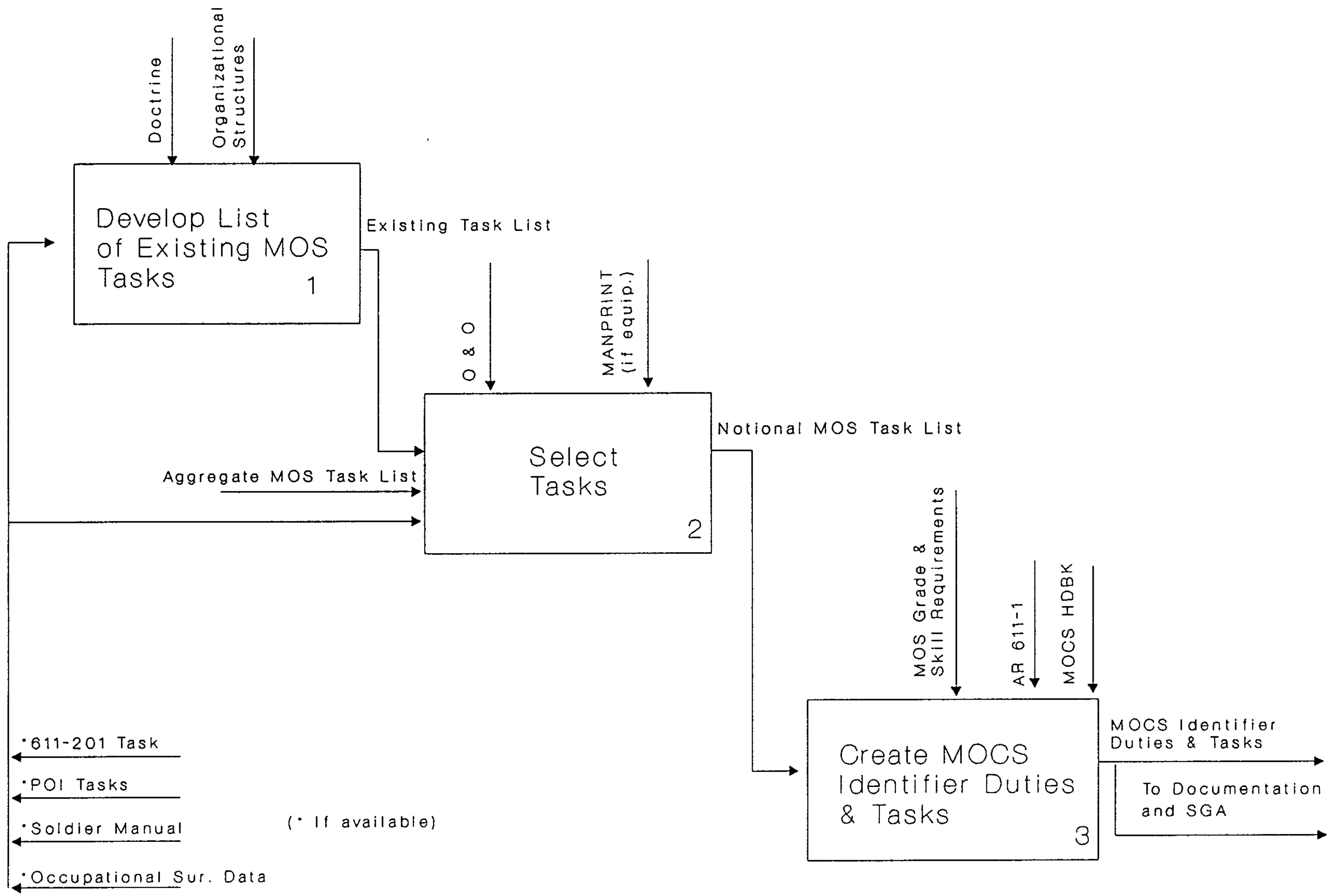
This activity consists of four independent analysis steps that each provide a unique data output that feed further operations-based analysis. These data outputs consist of (1) determining the number of projected MOS authorizations for outyear considerations, (2) determining if the MOS is to be SIMOS, (3) determining the impacts of the MOS on women in the Army issues, and (4) determining the MOS accession point. These analytical steps are essential in assessing the ability of the Army to support a new or modified MOS in terms of personnel supportability issues.



A0312 - Personnel Data Analysis

A0313 MOCS Identifier Duties & Task Analysis

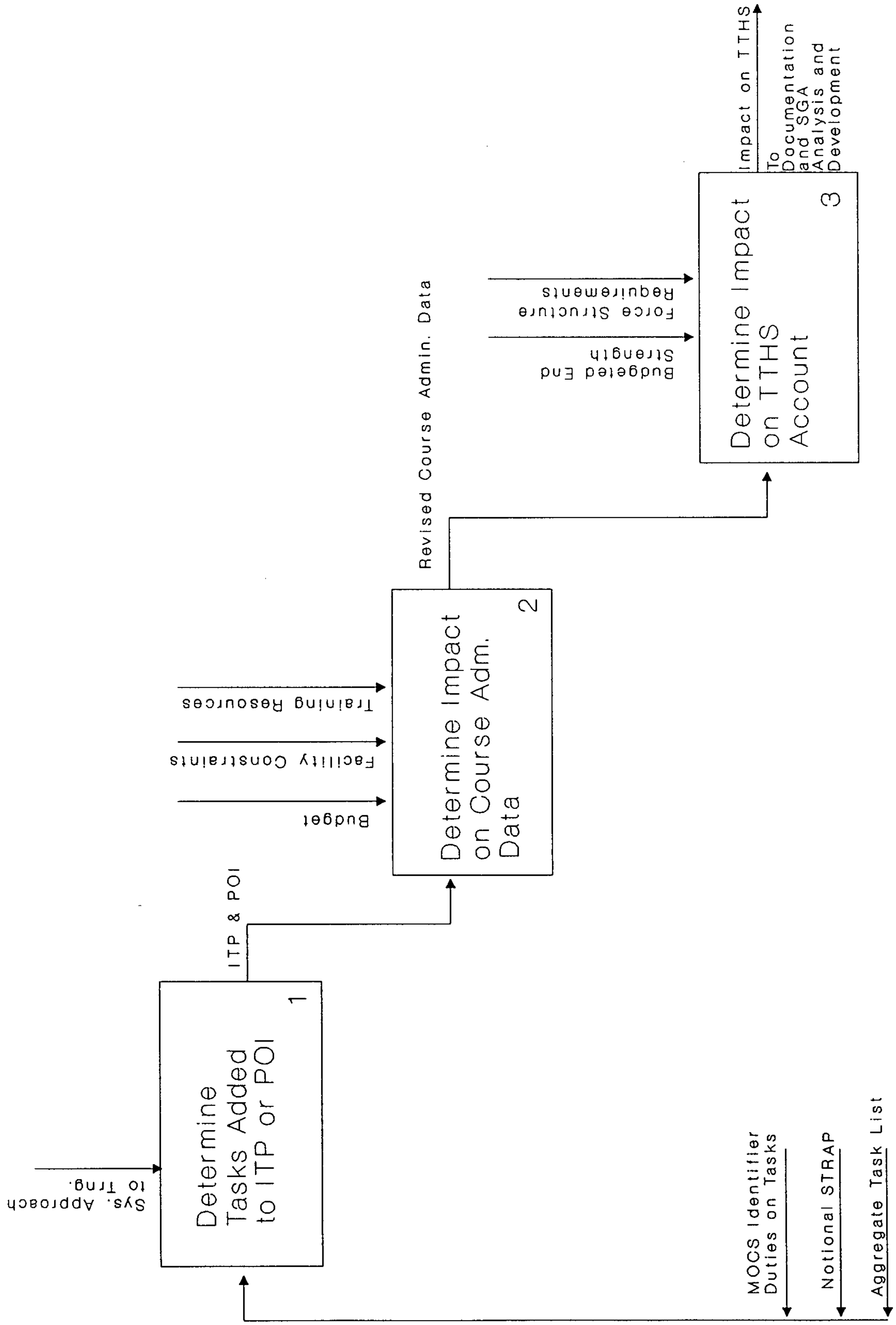
MOCS Identifier Duties and Task Analysis is performed in order to develop a task driven description of what duties an incumbent in an MOS is required to do. This analysis consists of three steps. The first step of the analysis is only required if the MOS restructuring action was triggered by personnel issues regarding an existing MOS. Otherwise, only steps two and three need be performed as the aggregate task list from requirements-based analysis becomes the primary input to the determination of MOCS identifier duties and tasks.



A0313 - MOCS Identifier Duties & Task Analysis

A0314a Training Analysis

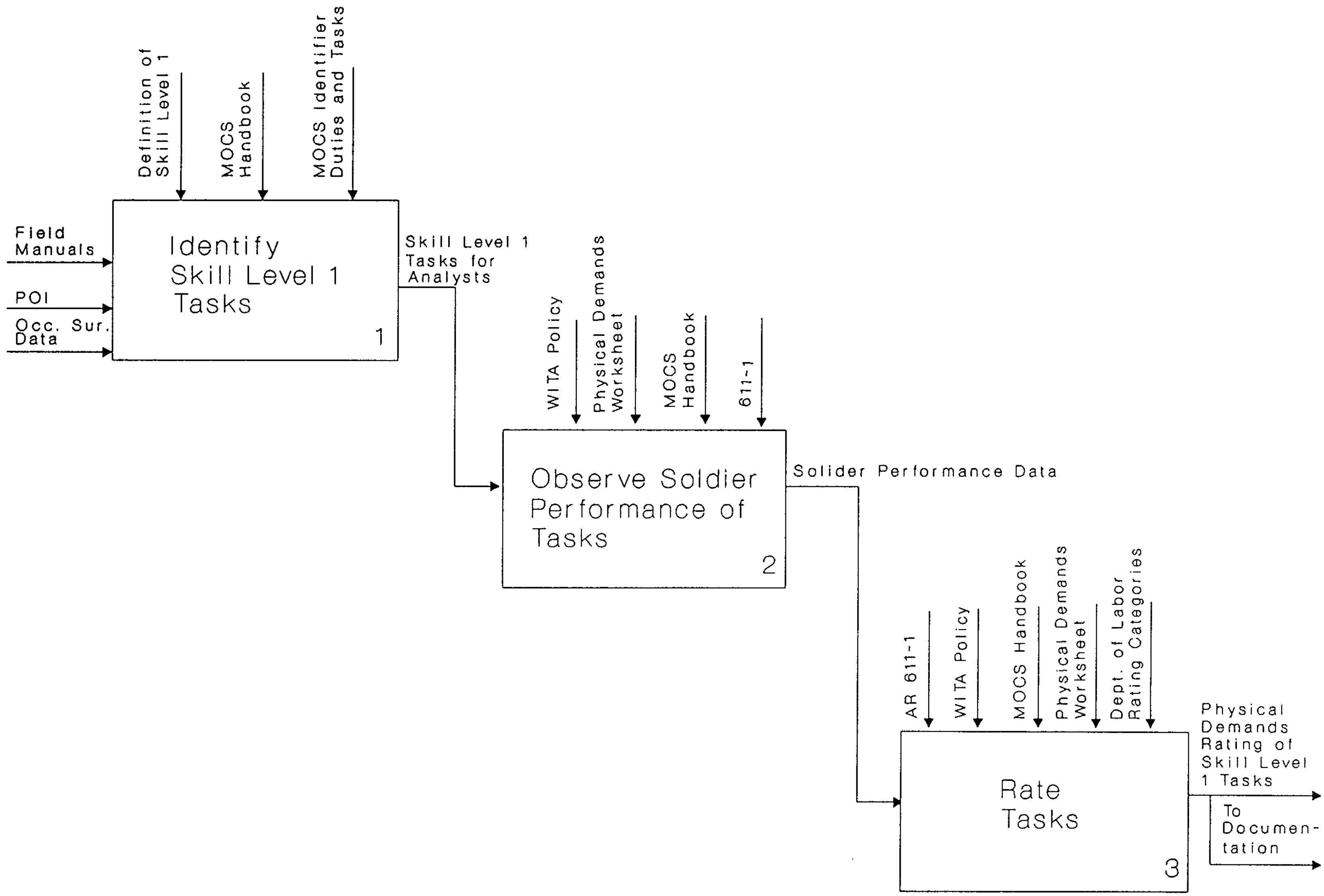
Training Analysis is the only analytical step in operations-based analysis performed primarily by an organization outside of the personnel proponent. This analysis step is normally performed by the training developer and is used to develop a final training strategy for the new or revised MOS.



A0314a - Training Analysis

A0314b Physical Demands Analysis

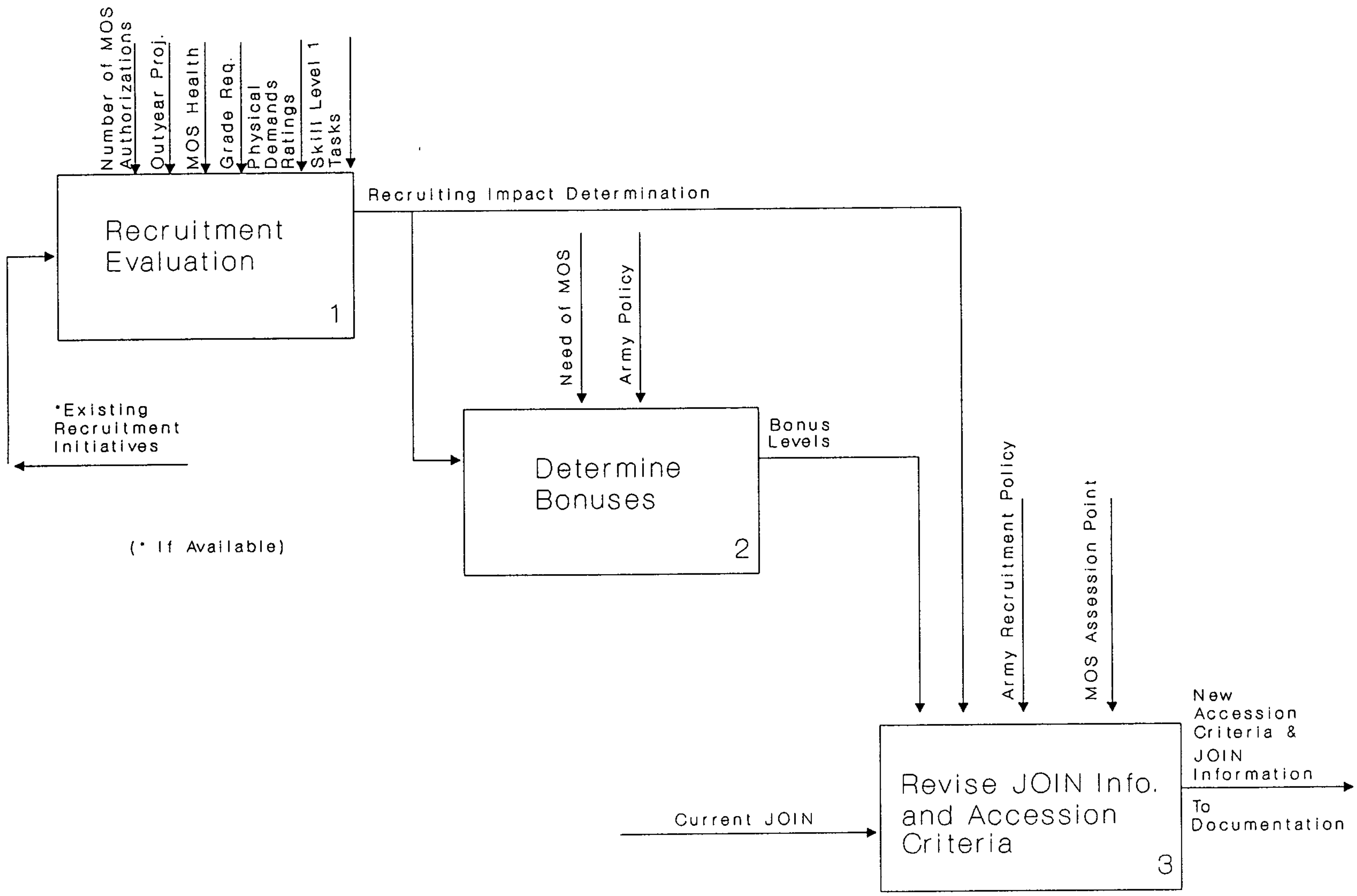
The goal of the three steps of this activity is to determine the physical demand requirements for all entry level tasks to be performed by the new or revised MOS. Based on the most physically demanding task the MOS will perform, the MOS is then classified as light, medium, moderately heavy, heavy, or very heavy by the proponent.



A0314b - Physical Demands Analysis

A0315 Recruiting Analysis

The activities of this step determine the impact of the new or revised MOS on JOIN. Any change in MOS title, skill level 1 tasks, physical demands, or accession strategy are determined for inclusion in recruiting programs and recruiting planning.



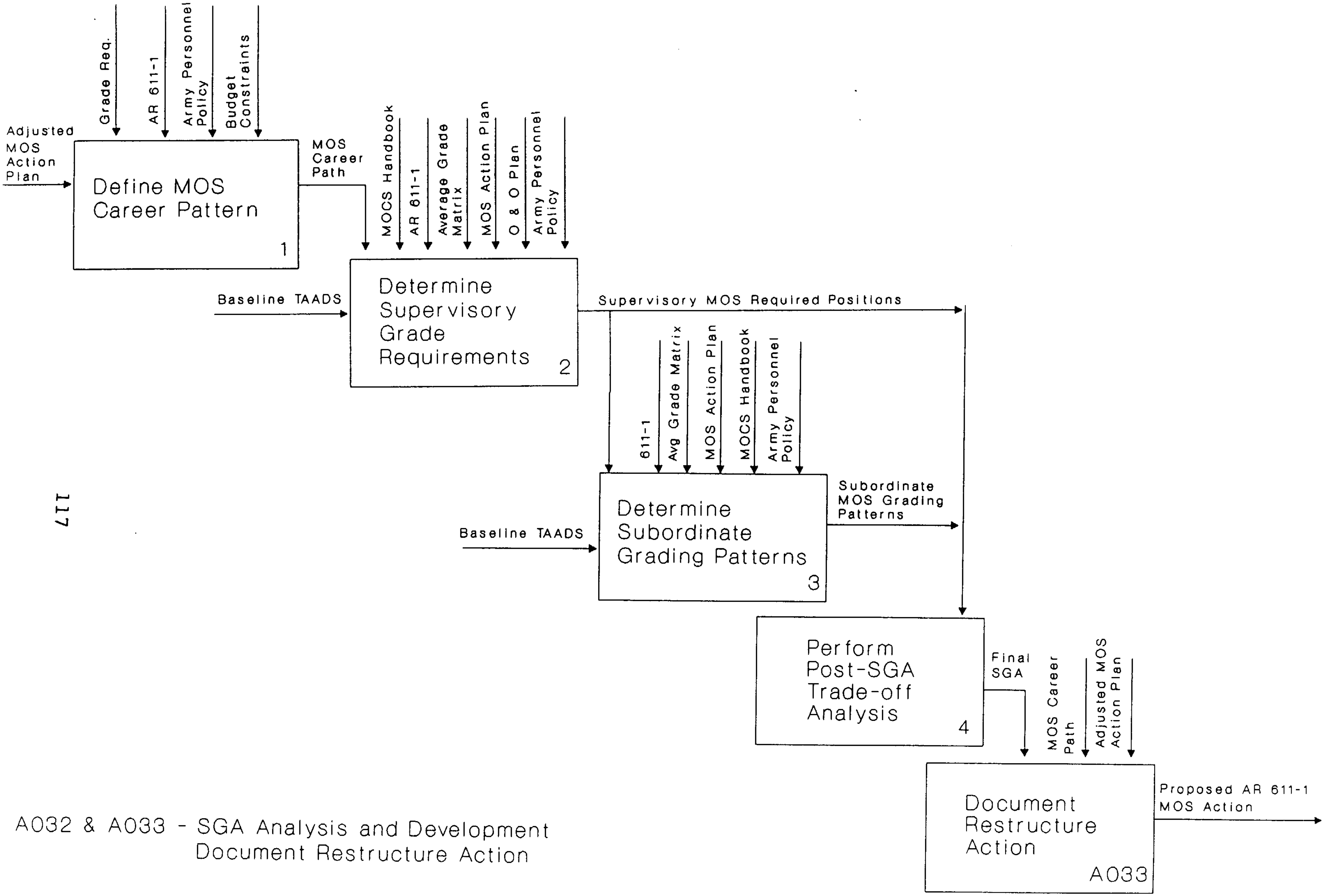
A0315 - Recruiting Analysis

A032 & A033 Standards of Grade Authorization (SGA) Analysis and Development & Document Restructure Action

The goal of SGA Analysis and Development is the creation of a standards of grade authorization that provides a grade structure that meets mission requirements and optimizes the career pattern of the MOS. The outputs from the analytical steps performed during SGA analysis culminate in the development of a standards of grade table. Development of the SGA table may require multiple iterations of the development process before a final SGA is developed.

The Post SGA Trade-off Analysis provides a systematic method of ensuring a balance between supervisory positions, subordinate positions, grade structuring, and career path. Trade-offs are made throughout the SGA development process. The results from this trade-off analysis would represent the SGA data input to the development and documentation of the proposed AR 611-1 MOS Action.

Once the restructure analysis is completed, the personnel proponent compiles all analysis outputs contained in the Adjusted MOS Action Plan and the final SGA and assembles them in the appropriate format. The final document is then bound and forwarded to the appropriate internal agencies. After internal approval of the MOS restructuring action, the report and its recommendations are sent to USAPIC for staffing and final approval.



A032 & A033 - SGA Analysis and Development
Document Restructure Action